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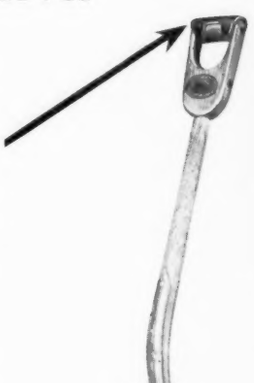

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Vol. 34, No. 1 CLEVELAND, OHIO, MARCH, 1909 Whole No. 199

ENAMELED CAST IRON SANITARY WARE

This is the first of a series of articles on the manufacture of porcelain enameled ware in which the methods of molding, pattern-making, designing, annealing and enameling will be fully discussed

BY DILLON UNDERHILL

THE commercial manufacture of so-called porcelain, enameled cast iron ware is of comparatively recent origin. Not more than 30 or 40 years have elapsed since bath tubs, lavatories, sinks, closets and other goods of this class have come into use. Many can recall the village hotel—and there are other public houses yet similarly equipped—where a marble or slate slab contained an elliptical opening, and concentric to this opening and fastened to the slab was a cheap china bowl. This was not dignified as a lavatory but was known as a wash basin or wash bowl. For many years the wash tub served the entire family for bathing purposes until the zinc lined tub came into favor. The unsightly color of this metal, however, as it became oxidized, was repellent, and much difficulty was experienced in keeping it clean. Tin plate was not much of an improvement, as frequently an inferior grade was used, the tin peeled or chipped off, and exposed the iron or steel, which soon rusted and became unsightly. The porcelain tub marked the next forward stride in bath tub manufacture, and its comparatively low cost as well as its desirability from a sanitary standpoint soon resulted in creating a heavy demand. The enameled cast iron tub followed closely on the heels of that made entirely of china clay.

Enameling.

Cast, wrought and malleable iron, as well as sheet steel, have been tinned so long and the process is so simple that it no longer excites comment. The discovery, however, that oxide of tin would unite with cast iron made the manufacture of enameled, cast iron ware possible. The combination of these two products alone does not produce the coat of enamel on cast iron. To the oxide must be added many other ingredients, and this particular phase of the work will be touched upon more in detail in a subsequent article. The exact mixture of the enamel itself is a state secret with each individual concern and the compounder of the enameling mixture is either a heavy stockholder, a member of the firm or is sworn to secrecy before he engages in this part of the work.

Production.

The production of cast iron, enameled sanitary ware is constantly growing from year to year. In 1907 it can safely be estimated that no less than 500,000 bath tubs were manufactured and installed. This estimate is based on the writer's knowledge of the output of three of the largest plants in the United States which averaged more than 1,000 tubs per day for practically the entire year. The output last year naturally fell below these figures when the tonnage in all iron and steel lines showed a marked decline. This estimate allows 700 tubs daily for the other plants in the United States, and to those conversant with this line of manufacture the estimate will undoubtedly seem conservative. Furthermore, the production of lavatories and sinks greatly exceeded that of bath tubs, and when this output is considered the magnitude of the industry can be appreciated.

Profits and Development.

That the profits from the business are large is indicated by the fact that no less than six of the manufacturers place the value of their worldly possessions at seven figures. There are so many difficulties, however, associated with the manufacture of this ware that failure has been the fate of many who lacked the necessary experience and knowledge of the various processes involved, or were handicapped on account of insufficient financial resources. It has been roughly estimated that to erect a plant to compete successfully at the present time would require an expenditure of at

least $500,000. To a large extent the development of this industry has been limited to the gradual growth of each individual plant, and the various processes which are now successfully used have been perfected only after many expensive experiments which were charged to the experience account. Very little research work has been done on strictly scientific lines, and until a very recent date the doors of these plants have been kept tightly closed to any who might carry the processes of one manufacturer to a competitor.

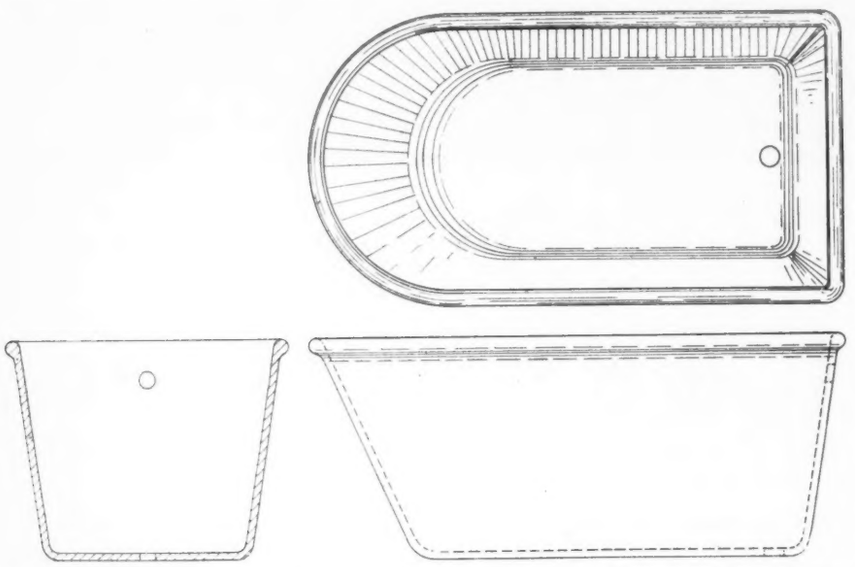


FIG. 1—PLAN VIEW AND END AND SIDE ELEVATIONS OF ONE OF THE EARLIER TYPES OF CAST IRON ENAMELED BATH TUBS

At one time a chemist was called in consultation by one of the leading sanitary ware producers to aid in solving some of the difficulties encountered, but he was so handicapped with the lack of information of the processes involved that he was unable to carry on the investigation satisfactorily. He appealed to the owners of the plant in vain, and they finally decided that rather than divulge their processes they would seek a remedy for their difficulties by costly experiments, and the chemist, although he ranked high in his profession, was informed that he would not be permitted to proceed with the work. This incident involved the enameling process only, but the same spirit of conservatism holds sway in all other departments, and even today, in the majority of foundries of this class, we do not find a competent chemist in charge. In some of these plants the loss from defective castings is very heavy, and this could almost entirely be eliminated if a competent man were employed to oversee the mixing of the iron and the melting operations.

Secretive Policy.

Despite the vigilance on the part of the manufacturers many have mastered this business and in some cases the heads of various departments have combined their knowledge and have succeeded in interesting capital and are now operating large plants. Therefore, it is a question whether this secretive policy is advisable. One interest has practically thrown open its shop as wide to visitors as manufacturers in other lines.

While the owners of these large establishments do all in their power to withhold information regarding their methods from their competitors, they do not hesitate to adopt the latest practice developed by others. When the bath tub was first placed on the market it was molded entirely by hand, but after considerable experimenting, one concern succeeded in developing a molding machine for this work. This information soon reached the ears of a powerful competitor, who was anxious to know how the machine was built and operated. To seek admission to this foundry for the purpose of viewing the machine would certainly have met with a positive refusal. The managers of both concerns were, however, on friendly terms, and while the one operating the molding machine was away from the shop the other gained admittance to the plant and secured all of the necessary information which enabled him to build a similar machine. On another occasion a machine was designed by one concern for molding small ware. A competitor heard of this and by some means he contrived to see the machine, and after securing the necessary sketches built one on similar lines and had it in operation in his plant in a short time. The foregoing is merely related to show to what extent the manufacturers of sanitary ware have endeavored to surround their manufacturing operations with an air of mystery, but despite their vigilance many of their secrets are generally known in the trade.

Production of Bath Tubs.

Inasmuch as the manufacture of bath tubs is the most difficult operation connected with the production of sanitary ware, this process will first be described. The method of making tubs by hand in the foundry will be discussed, as well as the various methods of making the patterns. The work of the various departments will also be dwelt upon, and finally we will describe the highest state of the development of this process which has resulted in the production of the

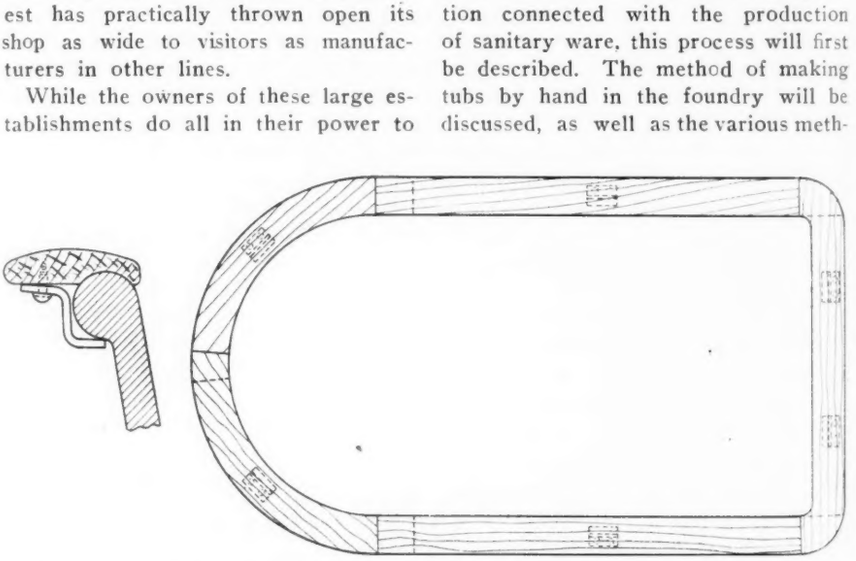


FIG. 2—WOOD RIM AND METHOD OF ATTACHING THE SAME TO ONE OF THE EARLIER TYPES OF TUBS

molding machine-made bath tub. The manufacture of small ware including lavatories, closets, sinks, integral and ordinary kitchen sinks, will be treated in succeeding articles, and other details of great value to those engaged

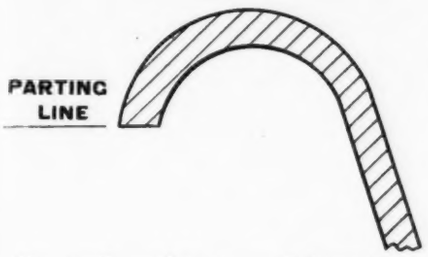


FIG. 3—CROSS-SECTION OF 2-INCH RIM

in this line of business will be thoroughly discussed.

First Cast Iron Tub.

One of the first bath tubs manufactured and which was considered a creditable piece of work at the time it was placed on the market is shown in Fig. 1. Artists claim that there is no beauty in straight lines, and it is evident that the original designer of this tub was not burdened with an artistic temperament. The designers were patternmakers who desired to secure a substantial pattern made of wood that would not easily be broken by the molder when rapping it in the sand. However, the pattern was easily repaired, if split, inasmuch as it consisted largely of straight boards glued together with small curved pieces added. The molder likewise desired plenty of draft, the more the better. The works manager was also of this opinion, and to reduce the foundry loss he thought it necessary to make the tub about ¾-inch thick on account of the large surface exposed, which he believed would chill the iron if made of thinner section.

In this way the first tub was de-

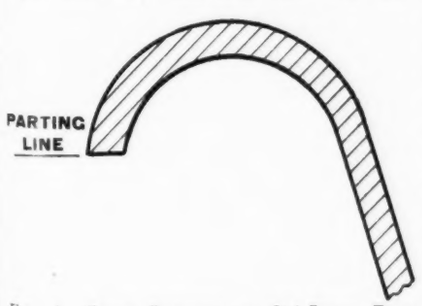


FIG. 4—CROSS-SECTION OF 2½-INCH RIM

signed and this model had practically no rim. Provision was therefore made for placing a wood rim around the edge, which was fastened with a clamp similar to a planer clamp. The bottom was practically flat, and the plumber was relied on to give the tub the proper drainage. Sometimes this amounted to ¼-inch in its entire length, but more frequently the tub was not inclined. The curve of the tub at the head was an arc of a circle that was the easiest for the patternmaker to draw. No draftsman was called into consultation, as the proprietor passed upon his ware by appearance. The idea that the head-end curve should conform to the back when the bather reclines in the tub would have been considered so utopian as to invoke ridicule. This tub, it will be noted, is shorter and deeper for its length than tubs in use today. All curves that connect the sides to the bottom are very shallow; the bottom is quite flat, while the thickness of the metal varies from ¾ to ⅝-inch. Even this

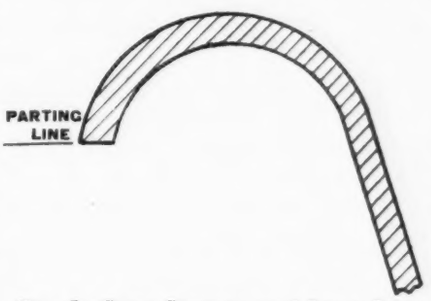


FIG. 5—CROSS-SECTION OF 3-INCH RIM

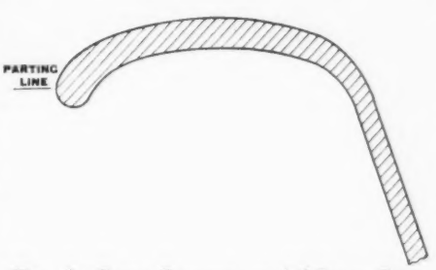


FIG. 6—CROSS-SECTION OF 4½-INCH RIM

small tub weighed approximately 300 pounds. A heavy head was placed around the tub for a rim, which was usually covered with a wood rim, as shown in Fig. 2. However, many tubs were installed in bath rooms and were boarded up on all sides. In the exterior appearance of the tub can be found the reason for this, inasmuch as it very much resembled the surface of sash weights.

The wood rim was frequently made in five sections so that the grain would be nearly parallel with the rim to prevent splitting, and was glued together with a long lap at the end of each section. It was usually made about 3 inches wide and ½-inch or more thick, depending on the curved or flat top desired. Two screws and Z-shaped, flat plates were usually fastened in a half dozen places to hold the rim rigidly in place. A groove was usually cut on the under side of the wood rim and the Z-plate pressing up and against the side of the rim made a very satisfactory and in-

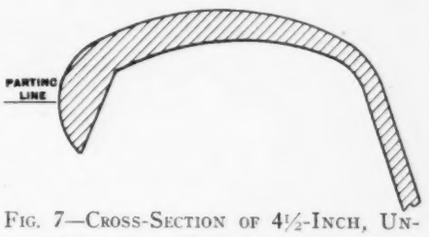


FIG. 7—CROSS-SECTION OF 4½-INCH, UNDER ROLL RIM, MADE IN GREEN SAND

expensive fastening. The steam in the bath room together with the water soon played havoc with the glued joints and the rim soon fell to pieces. It was, therefore, necessary for the manufacturer to devise a rim that would give satisfaction.

Cast Iron Rim.

The bulb-shaped rim was discarded and the roll rim, similar to the one shown in Fig. 3, but which at first was made much thicker to correspond with the thickness of the tub, was adopted. This rim is still used on many of the cheaper tubs, as it is easily molded on account of the small amount of sand that must be held up directly over the rim.

Molding Tubs.

Bath tubs are always molded upside down and the parting line is indicated in the sectional views of the rims, Fig. 3 to 8. It will be noted that the parting is made on the edge of the rim in Figs. 3, 4 and 5. This leaves the edge of the rim smooth and when the tub is poured from the top, as is frequently done, a very small fin is formed when good flasks

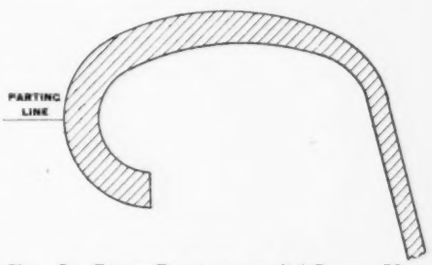


FIG. 8—CROSS-SECTION OF 4½-INCH, UNDER ROLL RIM, MADE WITH A DRY SAND CORE

are used. In an ordinary casting this fin is of very little moment, as it is easily knocked off, or can be chipped off with a chisel. With enameled iron ware all fins must be removed as the rim and tub are closely in-

spected by both dealer and customer, and as every defect is magnified by applying the enamel, the tub would have to be condemned entirely or graded as a second, thus eliminating all profit. Where any defects occur

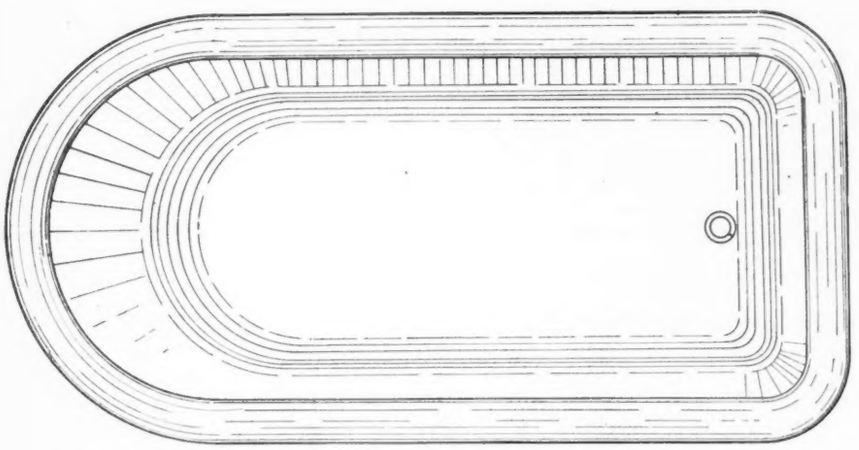


FIG. 9—PLAN VIEW OF A MODERN 3-INCH, ROLL RIM, 5-FOOT BATH TUB

which project outward, they must be ground off. For this reason tubs made with rims having partings, such as are shown in Figs. 6, 7 and 8, result in heavier losses in the foundry, and are considered of a higher grade. Furthermore, if the drag and cope do not close properly, a sharp corner is formed around the rims of the last three styles mentioned, and the tub is ruined. On the other hand, if a mismatch occurs with the first three styles of rims, making it thicker on one side than on the other, it does not materially affect the tub, provided the sides have not been cast too thin to prevent cracking when placed in the enameling oven.

Under Roll Rim.

The under roll rim makes the better appearance, and while it costs more to manufacture, it is in heavy demand. Fig. 8 shows the rim of a tub made with a dry sand core hung in the cope. This work will be discussed in detail under the caption of "Foundry Practice." We may state, however, that the cores are made in sections and considerable difficulty is experienced in setting them in place. The solution of the under roll rim, made in green sand entirely, is shown in Fig. 7. The under roll rim shown in Fig. 8 was adopted to compete with porcelain ware, as it is desirable for enameled cast iron ware to lose its identity and to assume an artistic form as much as possible. The extreme cost will militate against the production of individual patterns of enameled bath tubs, owing to the expense of the patterns. This, however, is occasionally done for large hotels when competing against manufacturers of porcelain tubs to decrease the sale of these as much as possible, even though little or no profit is made on the order.

A compromise between the ordinary roll rim and the under roll is shown in Fig. 6, and is cheaper to manufacture than the latter. The rims illustrated vary from the cheapest to the most expensive, and the prices of the tubs are in proportion. The rims shown in Figs. 4 and 5 are very popular and it can safely be stated that more 3-inch rim tubs have been sold up to the present time than any other style.

By referring to Figs. 2 to 8, it will be seen that the thickness of the metal greatly increases as the rim leaves the body of the tub. Tubs having 2 and 2¼-inch rims are usually made ¼-inch thick and the rim gradually increases to 5/16-inch at the edge. The 3-inch rims increase from ¼ to 7/32-inch, and the 4½-inch rims from ¼ to ⅜-inch or more. The rims are increased in thickness so that the tubs will hold their form better, inasmuch as they are annealed practically a half dozen times in the process of putting on enamel, to say nothing of extra annealing which some manufacturers do independent of the enameling operation. The rim being thicker heats more slowly than the body of the tub, and the enamel melts on the tub at a uniform rate. When it is taken out of the enameling oven the rim cools off slower than the body, so that more time is allowed for placing the enamel on the rim. It is essential for the rim to be as nearly perfect as possible, but a pin hole or dark spot on the side of the tub is easily overlooked.

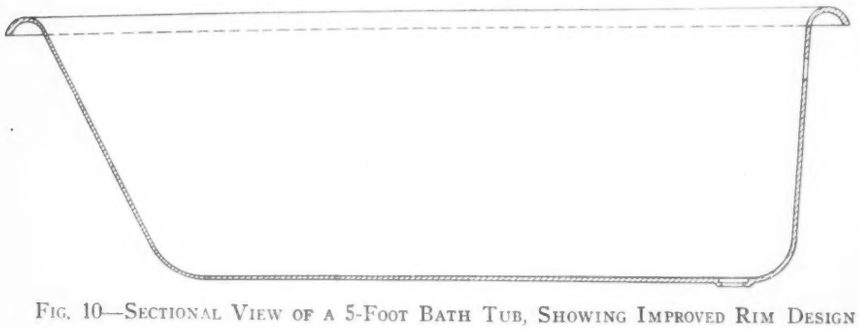


FIG. 10—SECTIONAL VIEW OF A 5-FOOT BATH TUB, SHOWING IMPROVED RIM DESIGN

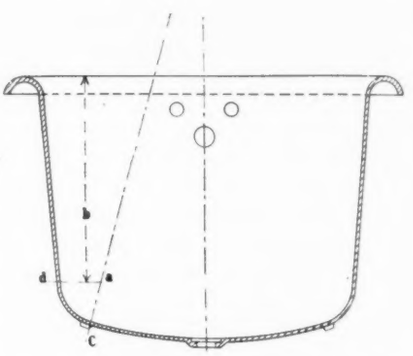


FIG. 11—CROSS-SECTION OF THE FOOT END OF A MODERN BATH TUB

High Grade Tub.

The design of an ordinary 3-inch roll rim, 5-foot tub is shown in Figs. 9, 10, 11 and 12. By comparing these with Fig. 1 it can be clearly seen that this tub has been built on more artistic lines. It is not nearly so short, having been lengthened to five feet, while the head, still an arc of a circle, has a wide rim which throws it in relief. The foot of the tub is also beautifully curved and gracefully unites with the sides, forming a harmonious design. Fig. 10 also shows the improvement of the roll rim as compared with the heavy section of metal in Fig. 1. The bottom is joined to the sides with generous curves at both ends, and instead of being parallel with the plane of the rim, it slopes to the outlet at the foot of

the tub. The metal in the tub shown in Fig. 10 is only about one-third as thick as that shown in Fig. 1, and the bottom is provided with a recessed outlet so that a fitting can be placed flush with the edge, making a neat connection. A section of the foot end of the tub is shown in Fig. 11, and a section through the head in Fig. 12. Instead of being flat, both bottom sections are curved, the curve at the foot being on about a 3-foot radius, while at the head at a radius of about 11 feet. This gives a fall of about 1 inch below a line drawn horizontally across the inside of the tub from the point C, Fig. 11, and C', Fig. 12. From the head of the tub to the foot there is a fall of ¾-inch. This insures thorough drainage when the tub is set level with the top of the rim.

The Feet.

The most important feature accomplished is the leveling of the top of the tub by using only one pattern

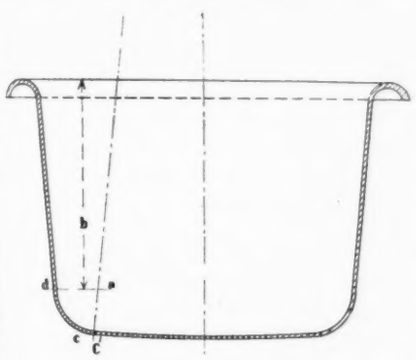


FIG. 12—CROSS-SECTION OF THE HEAD END OF A MODERN BATH TUB

for the feet or legs. Although the bottom has a constantly varying height for drainage the same foot may be used on any one of the four corners. This is accomplished by making the distance b, shown in Figs. 11 and 12, equidistant from the top of the rim to a center for swinging in an arc which forms the curves adjoining the bottom and sides. The radius of this arc must be exactly the same all along the side between the two sections shown. This arc will join the bottom curve at C and C' and at varying points between these two sections. It will be seen that C' is nearer to the bottom of the head section, Fig. 12, than C, Fig. 11, which is due to the curve being somewhat flatter, and having a larger radius at the head than at the foot. We therefore have for our common fitting surface the distance from d to C, but not from d to C', since if the foot should be made to fit beyond C it would not clear from c to C'. If this idea is carried further a series of tubs can be built to incorporate this one corner curve, and thus have one universal foot for all of the tubs made by one concern.

Late Design.

Plan and cross section of the highest grade tubs made today, which resemble those made by several large concerns, are shown in Figs. 13 and 14. The handsome appearance of these tubs cannot be clearly shown in line drawings, as there are three, compound curved surfaces joined in several cases. It will be noted that the outlet is placed in the center of the tub, and the drainage must be directed to this point. A section taken at D, Fig. 14, would be practically the same as that shown in Fig. 11, except that it would not have so much fall, since the distance from D to F would be only half that of a tub of equal length. A section taken at F would be almost identical with that shown in Fig. 12. The same principle of corner curves can also be carried out if duplicate feet are desired. Some concerns, however, set the feet to stand exactly on the corners, that is, so that the foot laps around both the ends and the sides, and they, therefore, make two separate feet, two of which will fit the diagonal corners. The feet are usually made large to correspond with the rim and to preserve a certain balance of the design as a whole. An under roll rim is used and is made without dry sand cores and corresponds to the one shown in Fig. 7.

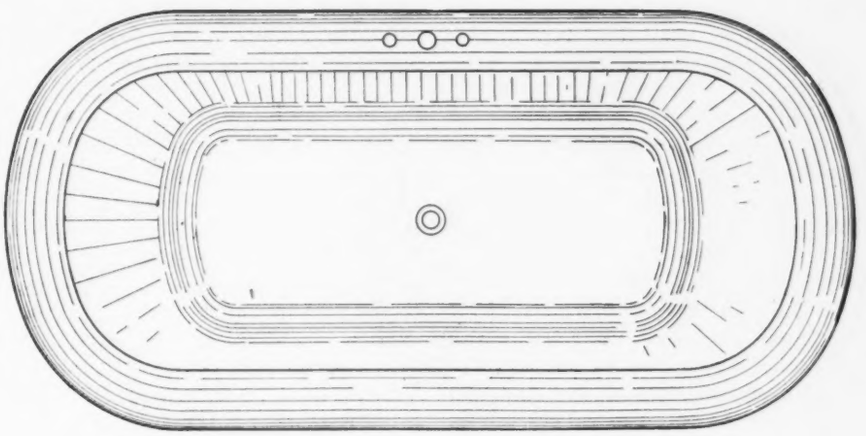


FIG. 13—PLAN VIEW OF A HIGH GRADE BATH TUB

Graceful lines are obtained by the use of a double radius of three centers for the end curves as shown in Fig. 13. The ends are somewhat flat owing to the large radius used for the middle of the curve, and when joined to the large corner curve makes a pleasing effect. A double curve is also used at the ends as shown in Fig. 14, and when these surfaces are properly joined, the present ideal in bath tub construction is reached.

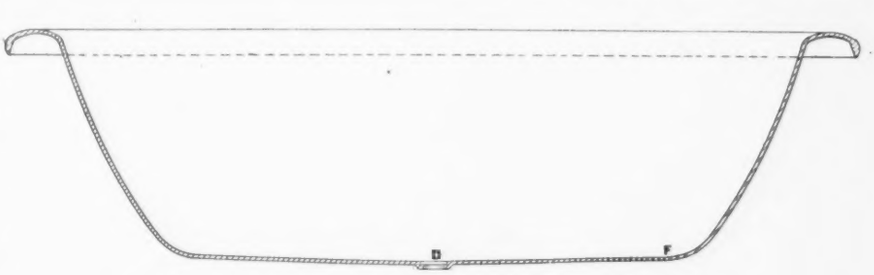


FIG. 14—SECTIONAL VIEW OF A HIGH GRADE BATH TUB

SASH WEIGHTS AND MALLEABLE SCRAP.

By W. J. KEEP

Question:—Machinery scrap is difficult to secure at the present time in our vicinity and is quoted at $14.00 a ton; stove plate scrap is held at $11.00 and malleable and steel scrap can easily be obtained at about $8.50. We want to use malleable and steel scrap in our cupola for making sash weights. What kind of flux should

we use and we would like to have the chemical analysis of limestone which can be used to advantage for this work. Will the introduction of steam into the blast pipe give us good results? What is the relation between the sizes of the upper and lower tuyeres, and what space should be left between the two? We have made castings of malleable scrap entirely, but they have invariably cracked while they were being poured. How can we use malleable or steel scrap successfully?

Answer:—For machinery castings you cannot use more than 25 per cent of steel scrap and no malleable. You should use about an ounce of aluminum to 100 pounds of iron in the ladle to prevent blow holes. Sash weights are usually made of discarded tin cans which are baled, but the iron has a white fracture and has little strength. To increase the strength of your malleable and steel scrap mixture and to make it fluid, stove plate scrap can be used to advantage. This iron should be raised to a high temperature as it rapidly loses its fluidity in the ladle. The limestone should be absolutely free from sulphur and should contain more than 80 per cent of lime. Weathered stone gives the best satisfaction in cupola practice, inasmuch as limestone from

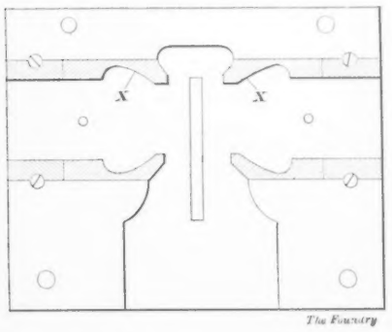


FIG. 1—CORE BOX FOR VALVE CASE CORES

a deep quarry rarely contains more than 50 per cent of lime, and is not an ideal cupola flux. Steam introduced in the blast pipe will give dull iron. I would suggest closing the upper tuyeres, flaring the lower tuyeres as wide as possible on the inside. Malleable scrap will not make gray castings.

CORE BOX FOR VALVE CASE CORES.

BY EMIL B. HORNE

A core box for cores of small valve cases of the gate type having solid seats, up to 3 inches in diameter, is shown in Fig. 1. Heretofore these cores have been made in three pieces, the main core and two sleeve cores, the latter being pasted onto the arms of the main core. By an arrangement of removable shells, shown in Fig. 2, and indicated by x, Fig. 1, it is possible to produce this core in one piece and in one operation. The core is more satisfactory than the one made in three parts, is stronger, and can be made

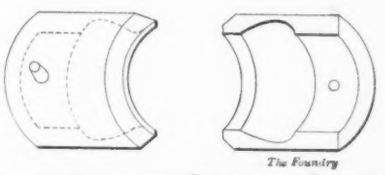


FIG. 2—REMOVABLE SHELLS OF CORE BOX

in much less time. The cost of core-making by the use of this box is reduced at least 50 per cent. The core which is made in one operation by the use of this box is shown in Fig. 3.

MIXTURE FOR BEARING METALS AND METHOD OF MELTING.

Question:—We have had considerable trouble making babbitt metal containing a small percentage of lead. At times the metal is satisfactory, but as a rule it is brittle and the fracture is by no means uniform. We presume the copper should be melted first, antimony next and then lead and tin. Is it possible to add enough tin with the copper to make a high tin alloy and then to add the other metals? In what manner should this be done?

Answer:—The trouble could be located more easily and a remedy suggested if you had given a formula. There should be no difficulty in making a good satisfactory babbitt containing the metals mentioned. The writer will presume that the formula is at fault and I am inclined to believe that it runs too high in copper, as that would cause the trouble stated. If your copper runs as high as 10 per cent, reduce it by one-half. Babbitt metals are made containing over 10 per cent copper, and although they possess great compressive strength they run sluggish and cannot be recommended for general use. An excellent babbitt mixture for heavy work follows: copper, 3.75 per cent; antimony, 10.50 per cent; lead, 25 per cent; tin, 60.75 per cent.

Melt the copper first, add 20 per cent of tin gradually so as not to freeze the melted copper, then add antimony and the balance of tin can next be added, but, if the tin is melted in an iron kettle "the hardening" is added thereto direct from the crucible in which it was melted. When the entire heat of babbitt is made in the crucible there is danger of overheating, as the crucible becomes very hot in melting the copper, and therefore the pot should be removed from the fire before all the tin is added, so that when the metal becomes super-heated from the red-hot walls of the crucible, cold metal will be at hand to cool it to a proper casting temperature. When melting the copper in tin babbitt mixtures keep covered with charcoal and add either the antimony alone or with a portion of the tin to form the "hardening," the idea being first not to freeze the copper, and second not to over-heat the more fusible metals. Lead babbitts are not so troublesome as they rarely contain copper because it makes them run sluggish. For a lead babbitt, melt a portion of the lead first, get it ready, then add the antimony which immediately dissolves, add the balance of the lead and finally the tin. Magnolia metal is a typical lead babbitt mixture and contains lead, 80 per cent; antimony, 15 per cent and tin five per cent.

K. K.

CHICAGO ASSOCIATED FOUNDRY FOREMEN.

"Ladies' Night" was celebrated by the Chicago Foundry Foremen on Saturday, Feb. 14, and after an illustrated lecture by Frank W. Smith on "Old Chicago," an informal reception was held in the lobby and gymnasium of the Lewis In-

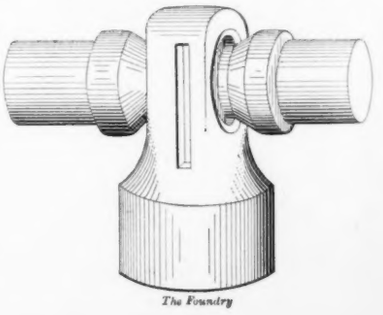


FIG. 3—CORE MADE COMPLETE IN ONE OPERATION AND IN ONE CORE BOX

stitute where light refreshments were served and dancing was indulged in. Owing to the success of this first "Ladies' Night" it will hereafter be an established feature of the association's annual functions. A committee was appointed to work up enthusiasm for a large attendance at the Cincinnati convention. There will undoubtedly be a trainload of members and friends from Chicago and vicinity, and an invitation has been extended to all foundrymen in the west and northwest who will undoubtedly be routed through Chicago, to join the Chicago foundrymen. Those desiring information regarding these arrangements should adddress C. E. Hoyt, secretary, Lewis Institute, Chicago.

PRODUCTION OF MALLEABLE CASTINGS-XII

The construction and operation of annealing furnaces and methods of charging and discharging the annealing pots

BY RICHARD MOLDENKE

A RADICAL change in the oven construction was devised by the author in building the works of the Pennsylvania Malleable Co., McKees Rocks, Pa. It was perhaps a rather bold departure. Thirty ovens of very large size were dropped into an immense concrete box, on account of occasional danger from high water. No braces of any account, the tops removable in sections, the simplest kind of construction, no tiles whatever being used, and an overhead crane to do the work. The result was that the annealing cost was practically cut in half, and today the connecting wall of every second set of ovens has been taken out giving a single oven some 40 feet long, 11 feet wide and 10 feet high, fired at both ends, and working with a variation of but 50 degrees Fahr. throughout the entire interior. Fig. 2 shows these ovens in their pit, and one of the top sections suspended from the crane. In Fig. 3 are shown four pots being conveyed by the overhead crane.

But the old style of ovens have also experienced improved methods of charging, the old system trucks finally being provided with power. This is shown in Fig. 4 which explains itself. The pots shown were, however, merely put on for the photograph, as they are not luted up or covered. Fig. 5 shows the method of transporting the pots within reach of the charging machine, the ovens being without the sphere of action of the crane. Fig. 1 gives an excellent view of the interior of an annealing room. There will be seen first, the iron floor plates, then the heaps of scale, in the middle ground two completed pots on their stools, the annealing boxes, bowed out in the middle through the action of heat and interior pressure of the charge. Finally, the oven fronts with the doors on hinges, some of them open.

Construction of Annealing Ovens.

The construction of the ovens is in the main simple. Fig. 6 shows a very good oven arranged for firing with coal. Ovens when built above ground must be tied together well, as they would otherwise soon go to pieces by reason of the expansion and contraction from successive firing. As a rule, they are used until they nearly collapse, and then a few more heats are taken from them on general principles. This is not very good for the castings within, as the variation in temperature must naturally become greater.

In the construction of an oven, the basic principle is the introduction of the heat from one convenient point, the spreading of that heat in a uniform manner, the holding out of as much free air, or in other words unconsumed oxygen as possible to save the pots, and the quick heating and very slow cooling of the oven itself. It is therefore necessary to have the combustion space for the fuel no larger than absolutely necessary, the draft regulation perfect, the bottom of the oven underlaid by a series of flues which allow the gases to circulate before going up to the stack, and thus get all the waste heat for use that it is possible to obtain without complicating the construction too much. It

FIG. 1—INTERIOR VIEW OF A LARGE ANNEALING ROOM

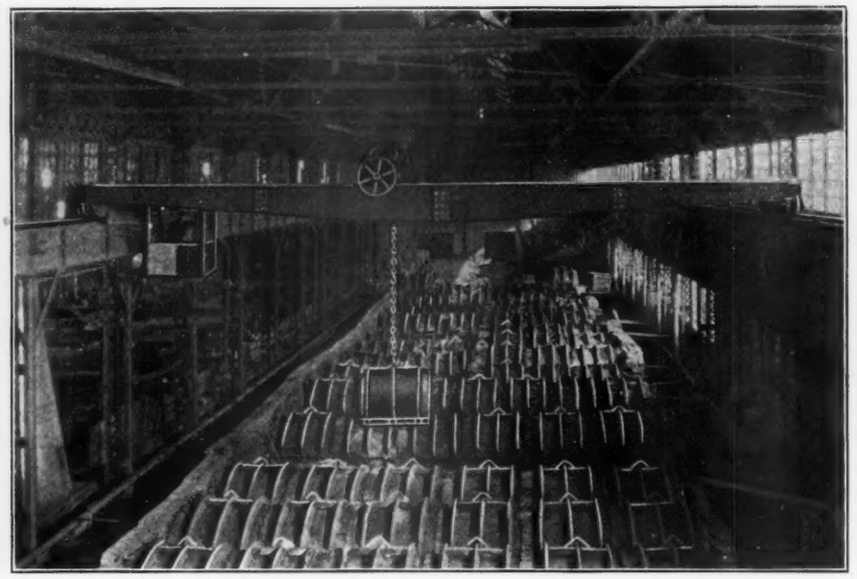


FIG. 2—ANNEALING FURNACES LOCATED IN A CONCRETE PIT BELOW THE GROUND LEVEL. FROM THE CRANE IS SUSPENDED A SECTION OF THE FURNACE TOP

is not necessary to put flues in the sides or the top, as has been done, for the instability of the structure, unless heavily braced, makes this undesirable.

With a series of 12 ordinary ovens above ground and four of these sets, each connected with a large stack, the waste heat was found to be so little that a concern that wished to put in hot water heaters for the boilers did not care to attempt the work. In fact it would probably have destroyed the draft had this firm been allowed to do the work.

A 4-inch lining of first grade fire brick for the sides, and 9-inch for the top, with common red brick for the outside is sufficient for the annealing ovens. Where the removable tops are used, one thinkness of arch brick on end, nine inches, alone is necessary, but the tops get pretty hot during the run. With so simple a construction, annealing ovens are not expensive, and it pays to have enough of them, so that the melting capacity of a works may not have to be curtailed while repairs are being made.

While Fig. 1 shows the doors of the annealing ovens hinged, this is seldom done, as the great weight of the construction tends to rack the oven. The doors, made in two sections for each oven, are usually handled by the truck similar to the pots. As the floor of the regular style oven is always laid with tiles, the cost for repairs on account of the damage done by the wheels of the trucks, is quite an item.

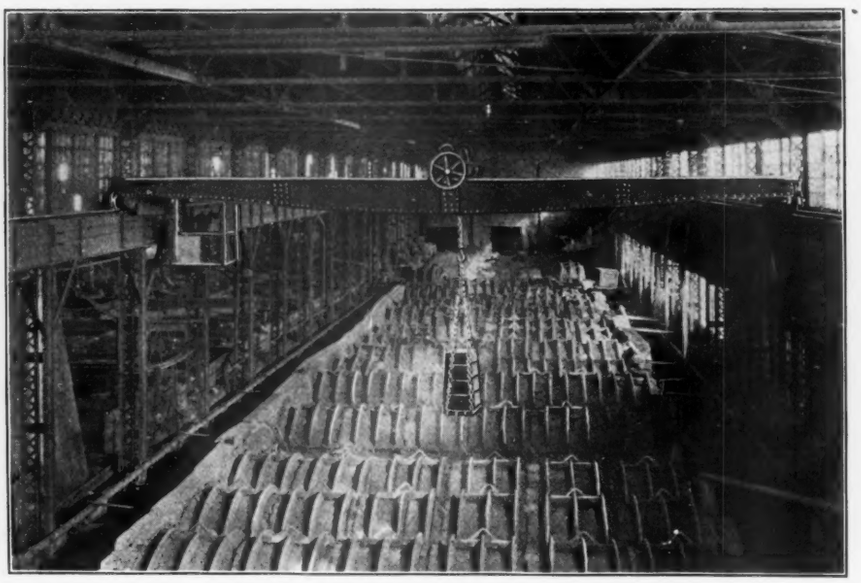


FIG. 3—FOUR CHARGING POTS SUSPENDED FROM AN OVERHEAD TRAVELING CRANE

Firing End of the Oven.

The firing ends of the ovens are always built internal, in order to prevent undue loss from radiation. A good long flame is desired, the ends of which come over the top of the fire box, and are deflected forward by the roof. With a good construction, when the oven is up to heat, only a foot of flame should appear over the top, and the dampers should be almost shut. The ideal fuel is natural gas, and with this it is simply necessary to arrange for three pipes into the fire box, loose brick closing up the entrance just sufficiently to furnish the necessary air for proper combustion. A very important item in this connection is the pressure of the gas, and consequent air supply necessary.

An elaborate series of tests made by the author to determine the difference of gas used at the ordinary fluctuating pressures of the city supply (between four ounces and 1½ pounds) and the same gas governed mechanically and issuing at two ounces, gave some interesting results which have a bearing on other methods of firing. The gas in the case of variable pressures was let into the oven fire boxes through three ¾-inch pipes, while the governed gas had three 2-inch pipes to issue from. The consequence was that with the larger pipes and slower flow of gas, this mixed with the air better and gave a good flame which rolled into the oven lazily, whereas the high pressure gas drew in a lot of unnecessary air, which tended to oxidize the pots unduly.

Results of Tests.

Among the results obtained with a large series of boxes carefully marked and watched, the following is of special interest. Three sets of pots, with boxes three-high each, were placed into an oven, with the gas not governed, the first in the presumably hot-test place, or close to the fire box. The second set was placed in the center of the oven, or likely the average of temperature. The last set was located in the front row, or coldest point of the oven. These places were retained throughout the trial, the boxes kept in their relative position from the bottom to the top of the pot, and the pots returning to their identical points. As the boxes of the pots burned out, they were replaced by

others, but the record of the used boxes was maintained. The same thing was done with another three sets of pots, this time with the gas governed.

The hottest pots lasted respectively 11, 15 and 16 anneals for the boxes from top to bottom with the gas governed, and 6, 8 and 10 the other way. The pots placed at the center of the oven gave 11, 13 and 14, respectively, gas governed, and 7, 10 and 11 the other way. Finally the coldest position in the oven gave 16, 18 and 20 anneals for the gas governed pots, and 8, 10 and 11 for the pots with gas at variable pressure. Rather strangely the hottest pots in the gas governed oven suffered less than those in the center, whereas the reverse would be expected. Evidently this was due to the position of the pot which, while very hot was protected more from the direct circulation of the gases in that corner of the oven.

The average life of the three sets of pots in the comparative tests was 15 anneals for the gas governed series, and only nine for those in which the air currents were not kept at a minimum. The average weight of the boxes forming the pots was 316 pounds, and when wasted away too much for further use had dropped down to an average of 87.5 pounds. This shows what a large amount of money is lost by direct burning up in the annealing end of the malleable foundry, and why some of this should be saved by utilizing the flakes, after the luting has been picked out as clean as possible, for replenishing the supply of scale.

Use of Producer Gas.

As natural gas is not always available, the next best fuel is producer gas made from soft coal. This is preferable to the use of the coal direct, on account of this very wasting away of the annealing boxes when the supply of air cannot be regulated nicely, as in the case of an open coal fire. Nevertheless, the author would not recommend the installation of a producer gas plant specially for annealing purposes, unless open-hearth melting furnaces are used in the first place. It is more satisfactory and about 10 per cent more economical to work with gas, but it takes more skill, and a small plant could hardly afford the expense of the installation, while the large plants will eventually all come to the open-hearth when castings are more generally bought under specifications.

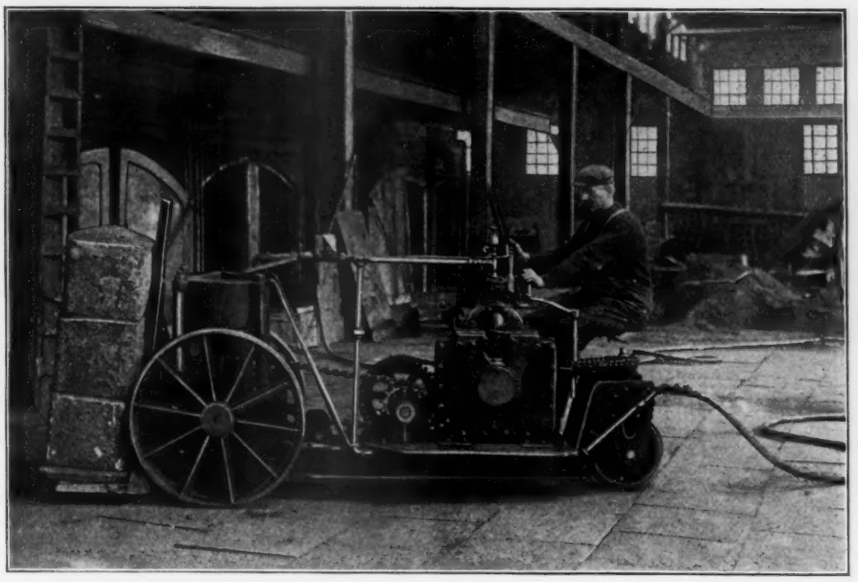


FIG. 4—PNEUMATIC CHARGING MACHINE USED FOR CHARGING FURNACES

The application of the producer gas to the annealing oven is not a simple matter as it is necessary to get a proper adjustment of air and gas for economical results. The result of much experimenting has shown that it is best to keep the fire box inside of the oven as for natural gas, and to add a gas box just outside which allows the gas to enter into the interior fire box, or practically the combustion chamber, and at the same time have the oven draft bring in the necessary air. The dampers for air and gas have two ports, should be easily adjusted and not jam if heated red hot at times. The air for each of the two gas ports should enter above them, so that the upward tendency of the gas makes it break through the air current, and thus mix well. The arrangement must be further so constructed that as little reflection backward of the heat of the burning gas acts on the fresh gas coming in, for if this gets too highly heated, soot is at once deposited and the ports are stopped up.

Use of Oil as Fuel.

Oil is also used. The author has successfully used this to the extent of many tanks for annealing purposes; with ordinary and superheated steam, compressed air, low pressure air, and direct without any carrying medium. The best results were obtained by having the oil under 40-pound pressure throughout the works, and governed, so that as the pressure went down the pump would start automatically. The oil was direct-

FIG. 5—METHOD OF HANDLING THE POTS WITH AN OVERHEAD CRANE

ed into the fire box of the oven through a very fine hole in the end of a ⅛-inch pipe, provided with a strainer to prevent clogging. This small oil pipe was within a 2-inch pipe, and was provided with a heavy cast iron nose on the end to retard burning off. The point thus made could be easily replaced without difficulty when necessary. Within the fire box a large tile was set on end to receive the spray of oil carried by the air from a blower, and at about three to six ounces pressure. Below the tile, as well as the burner proper, and to cover the old ash pit, a floor was laid of fire brick on 2-inch pipes through which the air passed before entering the burner, thus in a small measure pre-heating it. Through this floor at the rear, openings were left, also behind the tile nose to receive the oil and spread it, through which openings air passed upward, thus assisting in the combustion. The result was an intense heat, with a long flame, and very little gas carbon deposited.

In general, oil is not to be recommended for annealing purposes, as the action is intensely local, the portion of the crown right above the fire box going to pieces in very short time. However, good results are obtained so far as the castings are concerned, and where oil is cheap and coal expensive, it should be used by all means.

Use of Pulverized Coal.

Pulverized coal has also been used with success. The fuel is ground very fine and blown directly in just as oil would be. As the future, however, rather favors the gas producer, which will cost no more for installation, and is far safer to operate than grinding coal to the fineness required and storing it, it is a question whether, except in isolated cases, the direct coal firing method in dust form will form a great factor in this country. Those who have perfected its use do not say much about it, except that it works satisfactorily, but have put the matter away for the present.

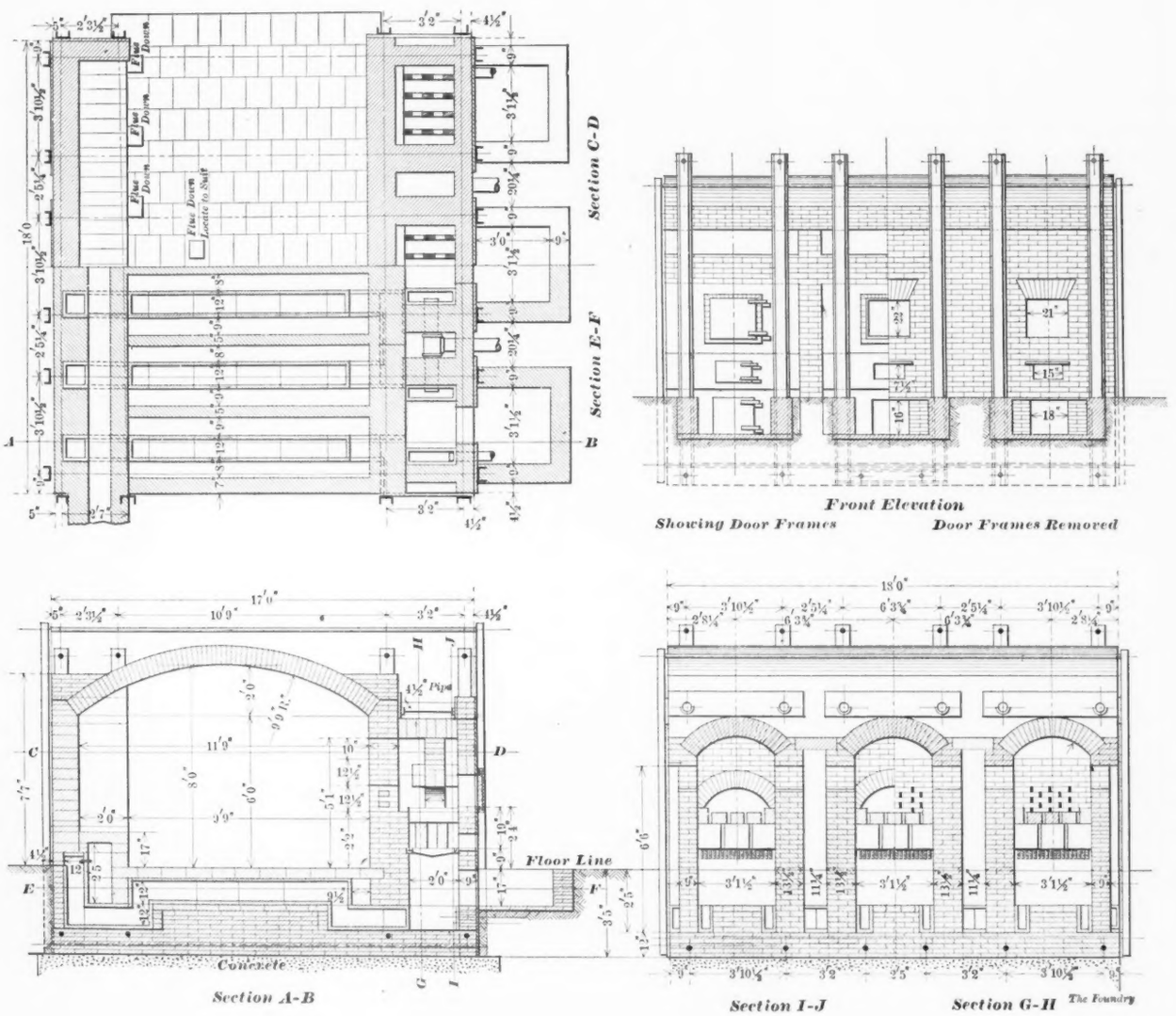


FIG. 6—PLAN AND SECTIONAL VIEWS OF THE MODERN ANNEALING FURNACE

BRASS MIXTURE FOR SEPARATOR BUSHINGS.

Question:—Will you kindly give us a good formula for brass separator bushings?

Answer:—An excellent mixture for this purpose follows: Copper 83, tin 5, phosphor tin 2 and lead 9. Another mixture which has given good results contained copper 83, tin 7, lead 9 and yellow phosphorus, 2 ounces. K. K.

STANDARD METHODS FOR DETERMINING THE CONSTITUENTS OF CAST IRON.

(Continued from Data Sheet No. 36.)

Determination of Phosphorus.

Dissolve 2 grams sample in 50 c. c. nitric acid (sp. gr. 1.13), add 10 c. c. hydrochloric acid and evaporate to dryness. In case the sample contains a fairly high percentage of phosphorus it is better to use half the above quantities. Bake until free from acid, redissolving in 25 to 30 c. c. of concentrated hydrochloric acid; dilute to about 60 c. c., filter and wash. Evaporate to about 25 c. c., add 20 c. c. concentrated nitric acid, evaporate until a film begins to form, add 30 c. c. of nitric acid (sp. gr. 1.20) and again evaporate until a film begins to form. Dilute to about 150 c. c. with hot water and allow it to cool. When the solution is between 70 degrees and 80 degrees C. add 50 c. c. of molybdate solution. Agitate the solution a few minutes, then filter on a tarred Gooch crucible having a paper disc at the bottom. Wash three times with a 3 per cent nitric acid solution and twice iwth alcohol. Dry at 100 degrees to 105 degrees C. to constant weight. The weight multiplied by 0.0163 equals the per cent of phosphorus in a 1 gram sample.

To make the molybdate solution add 100 grams molybdic acid to 250 c. c. water, and to this add 150 c. c. ammonia, then stir until all is dissolved and add 65 c. c. nitric acid (1.42 sp. gr.). Make another solution by adding 400 c. c. concentrated nitric acid to 1,100 c. c. water, and when the solutions are cool, pour the first slowly into the second with constant stirring and add a couple of drops of ammonium phosphate.

Determination of Manganese.

Dissolve one and one-tenth grams of drillings in 25 c. c. nitric acid (1.13 sp. gr.), filter into an Erlenmeyer flask and wash with 30 c. c. of the same acid. Then cool and add about one-half gram of bismuthate until a permanent pink color forms. Heat until the color has disappeared, with or without the precipitation of manganese dioxide, and then add either sulphurous acid or a solution of ferrous sulphate until the solution is clear. Heat until all nitrous oxide fumes have been driven off, cool to about 15 degrees C.; add an excess of sodium bismuthate—about one gram—and agitate for two or three minutes. Add 50 c. c. water containing 30 c. c. nitric acid to the liter, filter on an asbestos filter into an Erlenmeyer flask, and wash with 50 to 100 c. c. of the nitric acid solution. Run in an excess of ferrous sulphate and titrate back with potassium permanganate solution of equal strength. Each c. c. of N-10 ferrous sulphate used is equal to 0.10 per cent of manganese.

TO FIND THE LENGTH OF A CHORD TO DIVIDE THE CIRCUMFERENCE OF A CIRCLE INTO N EQUAL PARTS, MULTIPLY S BY THE DIAMETER.

N	S	N	S	N	S	N	S
1		26	.12054	51	.061560	76	.041325
2		27	.11609	52	.060379	77	.040788
3	.86603	28	.11197	53	.059240	78	.040267
4	.70711	29	.10812	54	.058145	79	.039757
5	.58779	30	.10453	55	.057090	80	.039260
6	.50000	31	.10117	56	.056071	81	.038775
7	.43388	32	.098018	57	.055089	82	.038303
8	.38268	33	.095056	58	.054139	83	.037841
9	.34202	34	.092269	59	.053222	84	.037391
10	.30902	35	.089640	60	.052336	85	.036953
11	.28173	36	.087156	61	.051478	86	.036522
12	.25882	37	.084804	62	.050649	87	.036103
13	.23932	38	.082580	63	.049845	88	.035692
14	.22252	39	.080466	64	.049068	89	.035291
15	.20791	40	.078460	65	.048312	90	.034899
16	.19509	41	.076549	66	.047582	91	.034516
17	.18375	42	.074731	67	.046872	92	.034141
18	.17365	43	.072995	68	.046184	93	.033774
19	.16460	44	.071339	69	.045515	94	.033415
20	.15643	45	.069756	70	.044865	95	.033064
21	.14904	46	.068243	71	.044232	96	.032719
22	.14232	47	.066793	72	.043619	97	.032381
23	.13617	48	.065401	73	.043022	98	.032051
24	.13053	49	.064073	74	.042441	99	.031728
25	.12533	50	.062791	75	.041875	100	.031411

THE FOUNDRY DATA SHEET, MARCH, 1909.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

ALLOYS FOR USE IN THE BRASS FOUNDRY

Discussion of the results obtained by alloying various metals---Solder mixtures and fusible alloys

BY JOS. H. HART

TO THE average operating foundryman the production of alloys is apparently largely a question of chance. Each foundryman has a different idea as to the relative proportion of the different materials composing the alloy, and a special mixture of metals for combination for some particular application in the industrial world is often considered an important business secret. Each one treasures his secret and also thoroughly believes in the possible chance discovery of combinations possessing other special qualities. Exact knowledge in regard to the effects of variation of each constituent upon the resulting compound is comparatively limited, although of late this chaotic condition is gradually giving way to more scientific treatment of the entire subject.

Value of Bearing Metals.

That the general lack of knowledge in this field is a very serious and significant factor is readily realized when we consider that the value of alloys used in bearing metals alone in this country today is over $50,000,000 per annum. Of this amount, at least one-half is consumed by the railroads in their locomotives and rolling stock and the constant increase in these, together with the wear and replacements of bearings, makes it a matter of ever increasing importance. The quality of the bearings affect very largely the life of the machine and the ability of the metals to fulfill their individual duties is dependent solely on the proper proportioning of the various constituents in their make-up. The chief reason for the unsatisfactory state of affairs is due to the fact that new metals from a chemical point of view are constantly becoming available for practical purposes. The development of electric furnaces and many chemical reactions such as the use of thermit in the production of chromalin, etc., have led to the possibility of their production in large quantities and their affect in the field of alloys is practically unknown, although experiments are being steadily conducted and data gathered along these lines.

Calcium.

Thus calcium has recently been isolated in chemical development by means thoroughly practicable, permitting of its utilization in large quantities in alloys if desired. The same is true of a number of other metals. Thus the number of metals capable of combination is much greater than formerly and this has increased proportionally the possible variations in the field of alloy production.

However, certain conditions are now recognized in alloy production and the field has become somewhat simplified from a theoretical standpoint, although much complicated as yet from a practical one. Thus the mixing of metals is a purely physical process, and certain combinations produce certain qualities in the resulting product.

Lead.

The more lead an alloy contains above 40 per cent, the higher will be the melting point of the alloy, and also the less it contains below this figure the higher will be its melting point. This phenomenon at the proportion of 40 per cent. is largely the result of chemical combinations and the production of eutectic compounds in the neighborhood of the melting temperature. A combination of lead and tin has a different melting point from either material by itself, and these compositions enter as a single substance in the composition of the alloy and affect its physical properties. Thus the melting point is at the minimum at 40 per cent lead. If still more lead is added, however, the melting point instead of decreasing begins to rise, but if a certain other substance is added, such as bismuth, the melting point will continue to fall. Bismuth has the further property, a peculiar one to this substance, of expanding on cooling. Thus the use of bismuth fills two requirements in its practical application, in that it not only tends to make the solder more easily worked by decreasing its melting point but also serves to counteract the tendency to contract on cooling, which is general among other metals. The mixture of cadmium with an alloy will still further lower its melting point.

The accompanying table gives the composition of a few alloys and fusible metals in common use.

Solders.

These solders are suitable for the various purposes varying according to the proportions of their constituents. Thus, solders 5, 6, 7 and 8 are peculiarly adapted to plumbers, tinsmiths and similar trades. No. 6 is somewhat of a favorite in these trades, although solder 8 is especially suited to work on lead or tin pipes. Solder 9 has a very low melting point and for this reason is often used for repairs about the household, its properties being such that it can be used by simply dropping it on a break or compressed in place on being held over the flame of a candle or gas jet. A reference to the table will bear out the statement before made that the more lead which the alloy contains over 40 per cent, the lower will be its melting point. Thus No. 7, which has 40 per cent lead, has the lowest melting point of any of the lead and tin alloys.

Alloys in Common Use.

Alloy	Lead	Tin	Bismuth	Cadmium	Other Constituents.	Melting Point, Degrees.	
	per cent.	per cent.	per cent.	per cent.	per cent.	Cent.	Fahr.
Solder 1	96.15	3.85				292	558
Solder 2	90.9	9.1				283	541
Solder 3	83.3	16.7				266	511
Solder 4	75.0	25.0				250	482
Solder 5	66.7	33.3				227	441
Solder 6	50.0	50.0				188	370
Solder 7	40.0	60.0				168	334
Solder 8	33.3	66.7				171	340
Solder 9	33.3	33.3	33.3			140	284
Steam boiler plug, alloy 1	48.4		12.8		Zinc, 38.8	171	340
Steam boiler plug, alloy 2	44.5		22.2		Zinc, 33.3	141	385
Steam boiler plug, alloy 3	42.1		42.1		Zinc, 15.8	123	253
Steam boiler plug, alloy 4	10.0	40.0	50.0			116	240
Sir Isaac Newton's alloy	30.0	20.0	50.0			100	212
Alloy suitable for casts	31.25	18.75	50.0			98	208
Rose's alloy	28.1	21.9	50.0			95	203
D'Arcet's alloy	25.0	25.0	50.0			93	200
Wood's alloy	25.0	12.50	50.0	12.5		60	140
Lipowitz's alloy	26.9	13.7	50.0	10.4		66	150
Expanding alloy	66.7		8.3		Antimony, 25.0	66	150

Solder Containing High Percentage of Tin.

Solders containing larger amounts of tin are not used as a general rule in the trade on account of their brittle qualities, and are thus not shown in the table. They are also too expensive for ordinary use. The addition of tin makes the solder tougher, however, but they are more difficult to work than those shown in the list where other metals

predominate. If tin were cheap, however, its use in this field would undoubtedly become more general, but at present the more tin an alloy contains the higher the market price. The addition of copper makes the solder harder. A solder containing 60 per cent of copper, 20 per cent of tin and 20 per cent of zinc makes a hard, white solder. This, it will be noted, does not contain any lead. A solder which is really a brass, and which is very easily melted, contains about 45 per cent of copper and 55 per cent zinc. This combination is sometimes used for soldering, binding and filling purposes.

Aluminum Solders.

The so-called aluminum solders are in reality combinations of aluminum and tin, the aluminum amounting to anywhere from 15 to 25 per cent of the whole. In some of these solders, small quantities of nickel are used, seldom, if ever, exceeding 2 or 3 per cent. The alloys used for automatic sprinklers and steam boiler plugs are given and these may, under some circumstances, be used as solders. These are called fusible metals and just where the line dividing fusible metals and solders lies, is indeterminate.

Practical Applications.

The above review gives a fairly good list of the general composition of the various alloys used and it will now be of interest to consider some of the features of the practical application of these materials, such as resistance to strains, prolonged and unusual temperatures, conductivity, etc. This subject has not had the exhaustive treatment and investigation that its importance warrants. Some experiments have been recently made, however, with a view to ascertaining the most advantageous method of making soldered joints and also to determine their stretching strength. One very important conclusion reached in these experiments was that pressure or strain applied to the soldering during the process of setting, affect very injuriously the strength of the joint. Particular care should be taken to support the upper piece above the lower when the solder is applied, bringing the two pieces together wtih a gentle pressure.

Strength of Solder.

Considerable pressure or strain at the moment of hardening will injure the interior structure of the solder and crystallization occurs resulting in a porous composition of much less strength than it would have been possible to obtain had the proper care been taken. This finding is in agreement with good engineering practice, as well as was the observation that a remarkable variation with time of the tensile strength of such joints. The maximum strength reached did not exceed 27,000 pounds per square inch. The solder which stood this strain was composed of three-fifths tin. This latter fact is in accord with the statement previously made that the addition of tin to an alloy tends to increase its value as a soldering material owing to the toughening effect on the composition. Another interesting point is that the time of each test was about 20 seconds and these tests were made with ordinary strength testing machines and with engineering materials such as are available in the ordinary engineering or physical laboratory. A decrease of 5 seconds in time of testing increased the tensile strength to considerably over 30,000 pounds to the square inch, but for all practical purposes such tests are unsatisfactory for the reason that tensions to this extent generally last a much longer time when they occur at all.

Solders Under Constant Strain.

The behavior of solders under constant strains is similar to soft metals or semi-fluid metals. They yield to an extraordinary amount and can be considered to be semi-fluid as a general thing. The variation of time with composition presents interesting features. Thus tensile strength increases the percentage of tin present, but when tensile strength with time enters as well, the product possesses its maximum strength at 60 per cent tin, showing the property as analogous to that of melting point and depending upon chemical composition as well. From these experiments it can be seen that for work subject to strains a composition of 60 per cent tin is the best possible combination. A much lower percentage of tin can be used for work where there is little strain with economy in cost of material.

Fusible Alloys.

Fusible alloys are used in the manufacture of fusible plugs in boilers, fusible plugs in electric wiring, for delicate castings, and for filling up defective places in ornamental castings. The United States government requires fusible plugs for boilers to be made of Banca tin. This preference, however, is largely sentimental and is not necessary for ordinary purposes. Fusible alloys possessing a lower melting point can be used in electric circuits as current interrupters, and serve as conductors for short lengths of current. In this case they act as a sort of safety valve, melting as soon as the current becomes too strong and thus breaking the circuit. Wood's, D'Arcet's or Rose's alloys are suitable for this purpose.

As will be readily seen from the table, by simply changing the proportions of the constituents any desired melting point is easily obtained. The various alloys shown are used for different purposes according to their different properties. Wood's or D'Arcet's are also suitable for soap molds, etc. Defective places in castings can be filled in with the expanding alloys.

Melting Point of Fusible Alloys.

The melting point of alloys which are fusible at low temperatures can be found in a simple manner. Tie a small wire around a piece of the alloy and suspend this in a bath of water if the melting point is under 212 degrees Fahr., or melted paraffine if above this temperature. Other carbohydrates can be used for the same purpose and mercury and even sulphur as well. Sulphur, however, is apt to interfere with the structure of the alloy and produce chemical reactions which tend to influence injuriously the proper proportions of the constituents. Phosphorus, arsenic and silicon are sometimes added. The general effect produced by the addition of non-metals is to render the material with which they are compounded more brittle. Sometimes they affect the variation of its properties with heat to a marked degree and this latter is shown in various iron alloys containing small percentages of impurities, used for tool making purposes.

Metal for Automatic Sprinklers.

In automatic sprinkler devices, such as are used as fire extinguishers, fusible metals are used. These metals have a melting point so low that a considerable heat, such as that resulting from the starting of a fire, will cause them to fuse and set in operation the sprinklers. These devices have been found to work satisfactorily at fairly high temperatures. The principal difficulty in this development is that metals do not fuse at a low enough temperature to render action prompt enough. This difficulty was peculiarly prominent in a recent fire in a fur cold storage apartment where the cold draft blowing from the air cooling chamber passed over the sprinklers and prevented the fusing of the alarms to such an extent that considerable damage was done before the sprinklers got into action. This phase of the problem is attracting the attention of manufacturers of fire extinguishers and similar devices and no doubt some metal, with a melting point low enough to remedy this defect, will soon be found.

The whole subject of alloys and the various combinations of metals for bearings, etc., is receiving increased attention as an exact science and interesting developments can be confidently looked for in the near future.

PREVENTION OF WARPED CASTINGS--III

A discussion of the influence of metal on the distortion of cast iron sections---Castings of various designs and methods of molding

BY JABEZ NALL

IN THE second article on this subject it was intimated that in making castings of a certain design, that the mold be cambered a certain amount that the resulting castings should come true to design after cooling. In other specific cases, while not imperative, this method is certainly preferable to either stripping the casting before cooling, or weighting it down to overcome internal strains.

This camber may be provided for in the foundry if the pattern is sufficiently flexible to permit this, or if the mold, as in some cases, is made from a short section of pattern, which is moved along as required. If the pattern is full length and rigid the camber must be built into it, and paradoxical as it may seem, in this case it is necessary to build the pattern wrong to have the casting come right. The amount of camber necessary can only be determined by experience. The foundryman, after having had considerable work along this line, will be able to judge from the proportions of the pattern and metal distribution, to what extent it should be cambered, and how close he may come to it is best indicated by the success recorded in the making of a 52-foot planer bed casting, described in the March, 1908, issue of THE FOUNDRY, which showed only a quarter inch vertical curvature in its entire length. Fig. 1 shows a section of the metal distribution. This is said to be the result of a calculation of "the amount of vertical curvature necessary in the mold to insure a straight bed when the casting is cooled, with an iron of a certain analysis." This being true, the estimator would confer a boon upon the trade if he would divulge the rule that governed his conclusions. My own experience, as well as that of a dozen different experienced foundrymen interviewed, show such a variety of results in the bending of castings in cooling, that it seems impossible to arrive at any constant or accurate formula, whereby this can be estimated with any degree of accuracy. While contraction is governed very largely by the metal thickness, and the general contour of the casting, together with the shrinkage of the iron from which the casting is made, still, there are many other factors that must enter into these calculations.

Castings of Various Designs.

Castings are of an infinite variety in shape, size, metal thickness, etc., and many of these have features that call for special consideration. Of

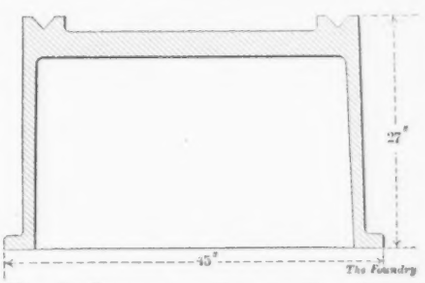


FIG. 1—SECTION OF PLANER BED, SHOWING THE METAL DISTRIBUTION

two similarly designed castings, the internal arrangement of one may be formed of green sand cores so yielding as to not retard contraction, while the other may be made of dry sand cores, the size and shape of which will offer great resistance to the contraction of the metal. These cores may at one time be made of sand so tempered and baked that they will crush easily under pressure, while the next set may be very hard and unyielding. This may be the result of the use of a trifle more water in tempering, or a higher temperature in drying.

Influence of Metal.

As one foundryman put it, the metal from which one casting is made may have been well adapted for the job and good results ensued, while using the same mixture for the next casting with a somewhat different grade of coke, the results may be entirely at variance than those secured at first. Not all foundries can afford the luxury of a chemist, nor can they always await the results of his tests. The temperature of the iron, as well as its contents, are factors of as much importance as the location and the number of gates. These, as well as other considerations, would involve a problem in mathematics for the purpose of ascertaining contraction, that the most skilled college professor would find difficult to solve. Facing these conditions, the foundryman is either compelled to guess at the proper method of molding, being guided by previous experience, or he can experiment and take a chance on the first casting, and upon the results thus obtained he can base his future methods. This will at least add to his experience, and this, while it should not be generally sanctioned or encouraged, is often resorted to, to ascertain what the results will be under certain conditions.

Camber in the Mold.

The types of castings whose molds should be cambered include those of such form that it is impossible to prevent their warping, either by stripping or weighting. Some of the parts may possibly require special attention, but are inaccessible, and possibly stripping or uncovering could not be done in time to do any good. The square, open back cast iron column which was used largely in the past, but which has been superseded by the built-up column of rolled steel shapes, is an example of this kind. This casting, though nearly obsolete, will illustrate the principle as well as any other. These castings were molded face down, and were either cored out with dry sand cores or anchored out in green sand, according to the practice pursued in the foundry making

these castings. If anchored out in green sand, this was lifted out with the cope. Because of the depth of these castings and the small allowance of metal in the supporting ribs, accentuated at the top edge if draft is allowed for coping out, as compared with the metal in the face of the column, which would perhaps be twice as thick, and being further rendered uneven by the amount of ornamentation upon the face, it was necessary to depress the mold in the center, usually about ¾-inch in 14 feet. Occasionally the depression was even greater, according to the variation in metal distribution, and the quality of the metal that was used for the casting. As it was impossible for the molder to do this, it was imperative that the pattern be cambered this amount to insure a straight casting.

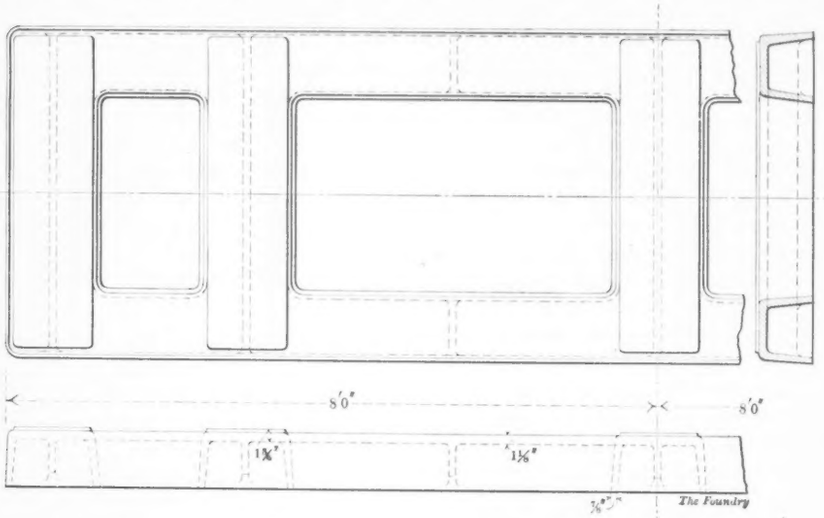


FIG. 2—PLAN AND CROSS-SECTION OF A GIRDER DESIGN BED PLATE

Bed Plate.

A cross-section of a girder design bed plate or frame casting, which involved similar difficulties in molding, is shown in Fig. 2. This casting is 16 feet long and 4 feet wide, and the top edge of the metal when inverted in the mold is ⅞-inch thick, tapering to 1⅛ inches, the thickness of the plate, this being further added to by the thickness of the finished pads, ⅝-inch. In molding, this was bedded in the floor face down, and the sand on the inside of the girder section lifted out with the cope. The pattern being in two parts for convenience in storage, was flexible enough to permit the molder to raise the end ¾-inch above the center, and it was molded in this position. After it was cast, it was left to cool with the flask closed. This proved very successful in practice, all of the castings being practically straight, or nearly so, that an ordinary finish allowance was sufficient to machine them true.

Foundation Plate.

Other castings, different in design, are shown in Figs. 3, 4 and 5. Fig. 3 shows a part plan and elevation of a foundation plate, the overall dimensions of which are 12 feet 2 inches x 26 feet 3 inches and 16 inches deep, made in two sections, right and left hand, but otherwise similar in construction, having T slots for bolts in both directions. Fig. 4 is a part longitudinal section on the line E F, Fig. 3, which is enlarged to show the relative metal distribution. The reference letters a, b, c, and d, correspond to the same letters in Fig. 3, and denote the parts shown in section. Fig 5 is a cross-section on the line G H, Fig. 3, and is also enlarged.

Method of Molding.

It is not necessary, nor is it our purpose, to inject into this article a description of the patternmaking and molding of this casting, as we are only interested in the ultimate results affecting the probable warping and distortion. This pattern was molded with the T slots down, and the interior of the casting was formed with dry sand cores. The metal in the plate was lightened out where possible, and the whole rendered of as even thickness of metal as possible. The pattern was made straight, as it was concluded that the T cores cutting up the plate in each direction would overcome the tendency of the face to warp while contracting. This evidently had some effect, but was not sufficient to resist this entirely, and the result was a deflection from the straight line of ⅞-inch of the total length. The deflection was grad-

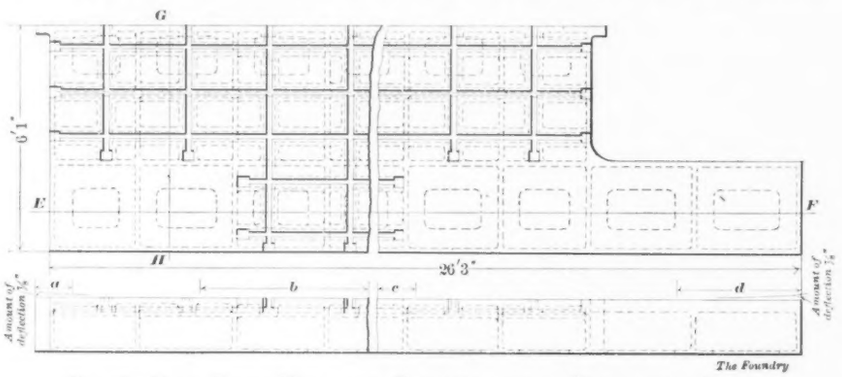


FIG. 3—PART PLAN VIEW AND ELEVATION OF A FOUNDATION PLATE

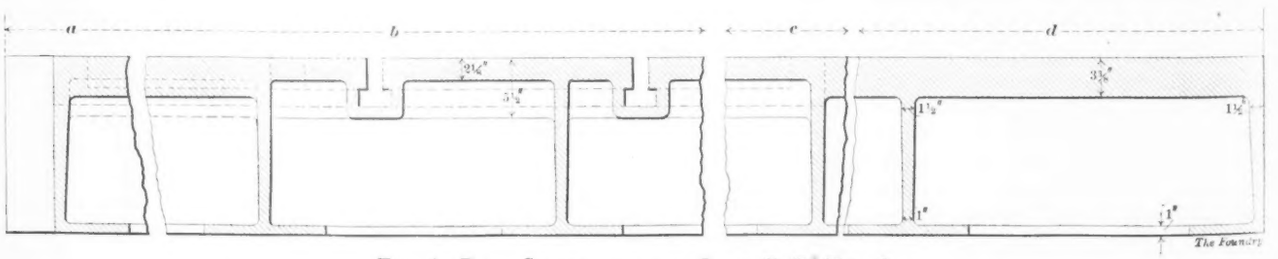


FIG. 4—PART SECTION ON THE LINE E F, FIG. 3

ual from the center of each separate casting, and they were warped crosswise a proportionate amount. As the castings were perfect otherwise, they were used for the purpose intended.

A quarter section of a foundation plate, 32 x 32 feet x 16 inches, is shown in Fig. 6. The T slots are shown full length in one direction only, and it was molded in the same manner as the plate just described, with the T slots down, from a pattern one foot longer than the half length, on a level bed. This casting warped 1⅝ inches in 32 feet. As it was impossible to straighten it, it was consigned to the scrap pile, and the pattern to the pattern shop to have the correct amount of camber worked on. When again used, the four sections resulted in a straight casting and there was no further trouble. The mold was cambered 1⅝ inches, the amount of the warping when the first casting was made. On page 52, volume 2, of *The Patternmaker,* H. J. McCaslin outlines his experience with a foundation plate of similar design and dimensions,

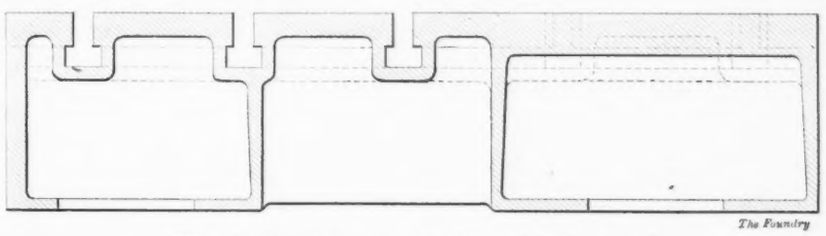


FIG. 5—SECTION ON THE LINE G H, FIG. 3

which was made in two sections of 16 feet each, and in this case the warping amounted to 1¼ inches. The pattern was cambered to give the proper bend to the mold and the next two castings were taken from the sand absolutely straight.

The author is fully aware of the fact that the value of these examples may be discounted somewhat by his inability to give the analysis of the metal from which these various castings were poured, as well as the shrinkage. The results, however, would indicate that there was little, if any, variation in the metal. The greatest contraction is shown in Fig. 2, while the disproportion of metal thickness is still greater in Figs. 3, 4 and 5 than in Fig. 6, and the amount of distortion is less. This is evidently caused by the cross slots cutting up the face of the plate into small section, which evidently affected contraction to some extent.

It will be noted that in all of the examples cited, the principle is the same and the lines of deflection follow the same directions, leaving the heavier face of the casting concave when cold. As previously stated, this is due to the cooling of the lighter metal in the top of the mold before the heavier metal has had an opportunity to set, and when this cools later the casting will invariably warp.

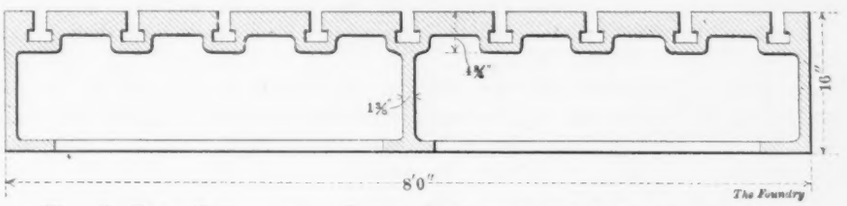


FIG. 6—CROSS-SECTION OF A LARGE SURFACE PLATE CAST IN FOUR PARTS

Circular Castings.

Sections of circular castings also frequently cause considerable trouble, owing to the tendency of their circumference to spread. These are variously affected according to their design and the method of molding. The sections are usually provided with arrangements for bolting them together with flanges on one side only. If the flanges are internal, the casting will have a still greater tendency to warp, while if external they are liable to neutralize the tendency to warp, and a true casting will invariably result.

A plain segment of a circle without flanges or other obstruction after cooling will be seen to have followed the lines of circumference, but it will also be noted that the contraction has not effected a change from the circular line of the mold unless the metal is very heavy, when it may straighten out to some extent. Many patternmakers use the same measurement rule throughout, and set trammels for the radius by the same contraction rule whether for steel or iron or any other metal. This gives too large a circle, and what is considered a distorted casting may otherwise be true to pattern. The trammels for the radius should be set to the common or standard rule measurements, but the full amount of shrinkage should be allowed, measuring on the circumference. With a radius of small dimension this would make little difference, but the larger the circle the greater the discrepancy. It is, nevertheless, a good rule to follow in all cases of segmental castings, except full circles or complete rings. Some cases will require the use of a small radius, depending on the design, and with such parts cast on that will resist the contraction of the whole.

Cast Steel Spur Gear.

This principle is illustrated in Fig. 7, which shows a quarter section of a cast steel spur gear, 13 feet 7 inches pitch diameter and 15-inch face, with cast teeth of 4-inch pitch. These sections are intended for bolting together, and the whole is bolted to an 8-inch, arm spider center. These castings, while showing slight variations, were found to straighten out an average of more than ¼-inch, and when the wheel was bolted together it was necessary to face the outside and slot some of the teeth for clearance at the root. The cause of this was evidently due to the end flanges

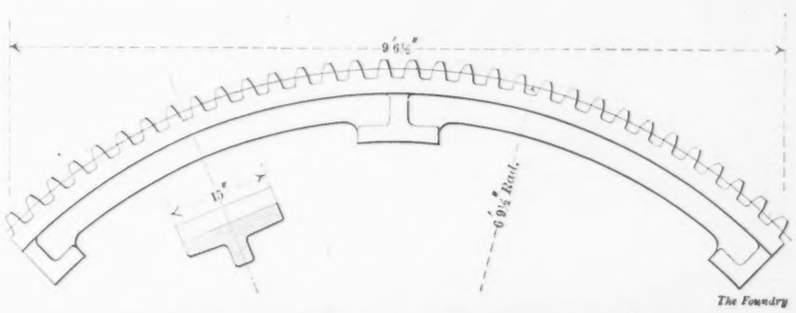


FIG. 7—QUARTER SECTION OF A CAST STEEL SPUR GEAR

which prevented free contraction and caused the casting to straighten out. This conclusion is arrived at notwithstanding the fact that we assume that the moulder relieved the casting somewhat at these points by cutting away the mold.

It will be seen that by striking a sector of a circle, 90 degrees, with a radius of 6 feet 9½ inches, and then add to this dimension the shrinkage allowance of 3/16 inch to the foot, and if with this radius we strike another line from the same crown point, we will have a difference of ⅜ inch at the opposite point. If we add to this the former deflection of ¼ inch, it is probable that a scrap casting will result.

There are many other forms of castings that cause more or less trouble in the foundry, and experience alone can best teach how they should be successfully molded. The best way to retain the lessons taught by experience is by the judicious use of a good note book, and to the young pattern-maker or molder I would suggest this as one of the best investments that he can make.

HINTS ON CASTING ALUMINUM

THE LIFE of a crucible used for casting aluminum may be considerably lengthened by using it for a couple of heats for melting copper or bronze, because the melting heat of aluminum is not sufficiently high to harden the pot, so that it wears or rubs away, particularly at the top where the furnace tools come in contact with it. Also, in melting aluminum when a portion of the charge has run down, be careful never to freeze this melted metal when charging additional metal. The cold material should be added before the first charge has completely melted in order that it may lie on top and become heated before descending into that which is liquid. This should be continued until the pot is full. This is unquestionably the best way, but it sometimes happens that the furnace is neglected until the first charge is entirely melted, then add no more cold stock than the melted metal will dissolve. Otherwise, it will freeze and when it commences to remelt will expand and break the crucible. This is a point peculiar to aluminum, and is responsible for many otherwise mysterious leakages of crucibles. The strained crucible does not always leak at the time the damage was done, but may run a couple of heats before it gives out. Also, no buttons should be left in the crucibles. This is a point not so important with brass, a small button rarely does damage, but with aluminum these buttons cause bottom leakages.

Use of Aluminum Scrap.

Borings, turnings and grindings of aluminum should not be melted alone but should be stirred into a pot half full of melted metal, which has been heated sufficiently to dissolve the turnings, and when the metal becomes chilled allow it to regain its heat before adding more turnings. When the crucible has been filled in this manner there will be a large amount of "mush" on top; the same thing occurs in melting scrap aluminum, but not to any great extent with clean ingots. If this mush is skimmed off considerable metal is lost. It should, therefore, be reduced to the metallic state, or rather in the case of aluminum the dross should be separated from the metal with which it is entangled. This can be done by the use of a flux. At one time it was the idea that no flux could be used on aluminum, and the pasty dross which sometimes forms on top when melted had no value to the brass founder. This idea is not correct as there are several fluxes of value to aluminum such as common salt, which is now largely used; potassium nitrate, or saltpeter, is also good. It should be pulverized using two or three ounces to a No. 100 crucible. The mush must be at a red heat or the reaction will not occur, and unless it does, this flux is valueless. The reaction is rather violent, and as soon as it commences the cover should be placed over the furnace.

Good Aluminum Flux.

Chloride of zinc is a most excellent flux for aluminum. This is the flux used in soldering brass or copper. It is commonly made by dissolving zinc in muriatic acid. It is not advisable, of course, to use the flux in liquid form, for obvious reasons. It can be done, however, with care, and acts just as well as the dry salt. Chloride of zinc is not expensive and is easy to obtain. It can be prepared conveniently from the oxide, the white substance that adheres to the crucibles used for melting yellow brass. This is collected and when used for fluxing aluminum, a couple of ounces can be placed on a piece of paper and made slightly wet with muriatic acid, before being tossed into the surface of the melted metal, when it is allowed to dry before being stirred in. In practice, the writer has found Yagers soldering salts a most convenient means of fluxing aluminum. A slight reaction occurs, the oxide of aluminum being left floating on the surface of the metal as a powder. When a considerable quantity of this oxide has accumulated, it should be riddled through a No. 32 sieve which separates the particles of metal. These are charged in the crucible and brought to a red heat, then treated with the chloride or salts, the metal being thus largely recovered.

K. K.

RELATION OF SHRINKAGE AND SILICON IN CAST IRON.

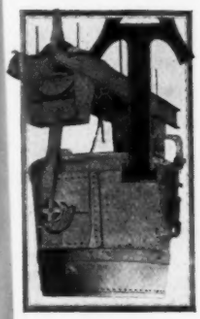
By W. J. Keep

Question:—We would like to know what shrinkages correspond to given percentages of silicon?

Answer:—An increase of phosphorus will reduce shrinkage while an increase of sulphur will make it more pronounced. Sulphur is always kept as low as possible and phosphorus cannot be above 1 per cent, without a loss of strength. In such light sections as hardware and stove plate castings an increase of silicon increases the strength, but the same mixture would make a large casting weak. The slow cooling of a casting 1 inch thick will decrease the shrinkage to 75 per cent of what it would be in a casting ½ inch thick poured from the same ladle of iron, both having the same percentage of silicon. From this it is apparent that the amount of shrinkage will not indicate a definite percentage of silicon. However, if it is the intention to regulate the per cent of silicon in castings by the measure of shrinkage, and if a fairly uniform iron mixture is used, a standard size test bar should be adopted and the shrinkage per foot of this bar should be measured. If the iron is too hard, increase one of the grades which contains the highest percentage of silicon. When the mixture is exactly right, the shrinkage of the same should be adopted as a standard, and the change in silicon for each 1/10-inch shrinkage can thereafter be easily calculated after the percentage of silicon has been ascertained by analysis.

INTERESTING TESTS OF STEEL CASTINGS

Ballistic test of a cast steel cylinder to detect internal strains---Hydrostatic tests of high pressure valves



THE production of cast steel locomotive cylinders is a comparatively recent development in the steel foundry industry, and service tests of these castings made by some of the leading trunk lines would indicate that gray iron cylinders will soon be crowded for supremacy in the railroad field. Experiments are also being conducted which may ultimately lead to the casting in steel of small gas engine cylinders for automobiles and motor boats. To cast the thin sections of these cylinders successfully is, however, a difficult problem for the steel founder to solve, and until this is accomplished he will be compelled to devote his attention to the larger and heavier castings of this type. Several large orders were recently placed by the railroads for cast steel locomotive cylinders and several foundries have equipped for this work.

Locomotive Cylinder Test.

In addition to the service tests conducted by the railroads, the United States government subjected one of these cylinders, made by the Penn Steel Casting & Machine Co., Chester, Pa., to a ballistic test at the Indian Head prooving grounds near Sparrow's Point, Md., for the purpose of ascertaining the extent of internal strains. The casting, although thoroughly annealed before shipment, was made of the same steel mixture used in several cylinders cast at that time. A test bar from this heat showed a tensile strength of 76,500 pounds per square inch, an elastic limit of 37,500 pounds per square inch, an elongation of 26 per cent and reduction in area of 31.2 per cent. The analysis was as follows: Carbon, 0.29 per cent; manganese, 0.50 per cent; sulphur, 0.034 per cent; phosphorus, 0.034 per cent, and silicon, 0.357 per cent.

Metal Thickness.

The metal thickness varied from one to four inches, proportions favorable to the development of strains which cannot always be eliminated in the anneal. Notwithstanding the fact that three shells were fired at the casting at a distance of 30 feet, not a check appeared nor was the casting injured in any way except where the shells passed through or were imbedded in the steel.

Ballistic Test.

The cylinder as it appeared after the test is shown in Fig. 1. One

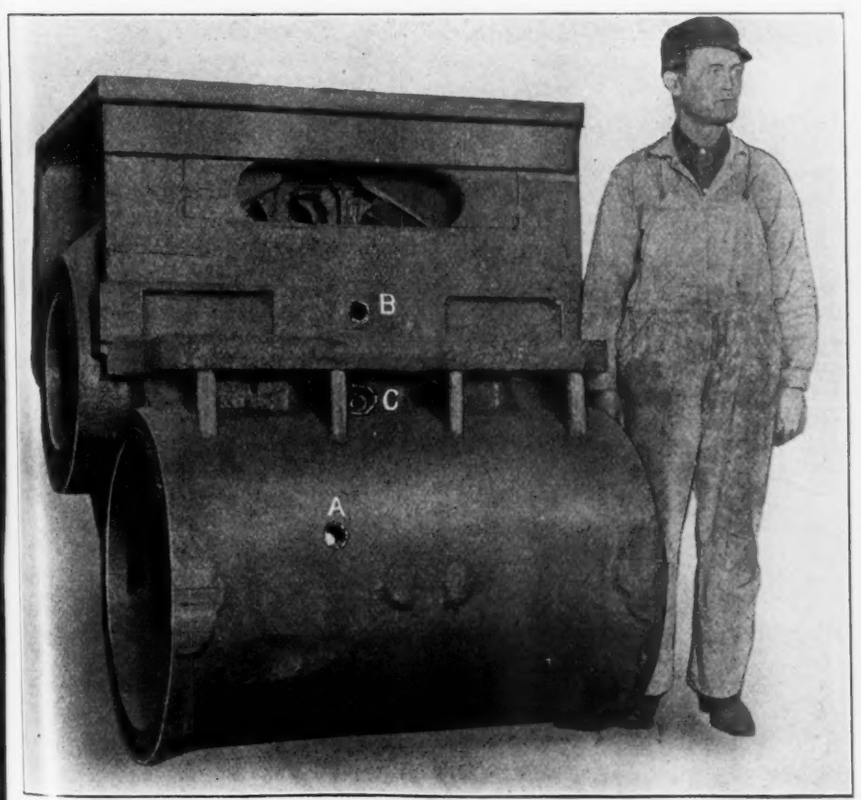


FIG. 1—CAST STEEL CYLINDER SUBJECTED TO BALLISTIC TEST TO DETECT INTERNAL STRAINS

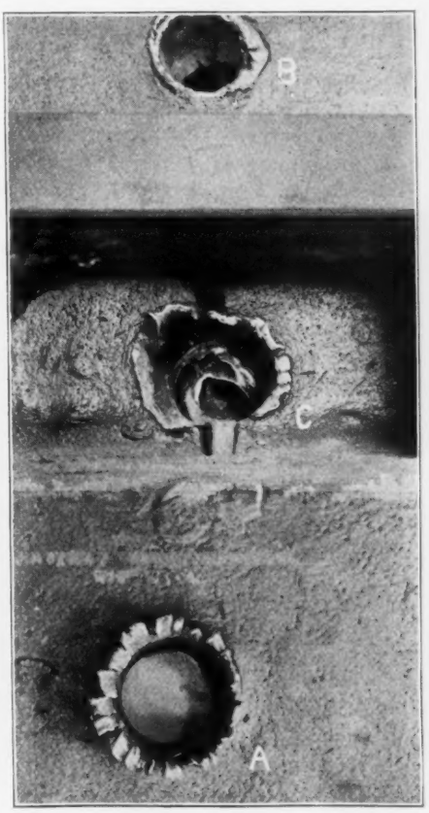


FIG. 2—A SHELL PIERCED THE CYLINDER AT A, BUT THE OTHER TWO WERE IMBEDDED IN THE METAL AT B AND C

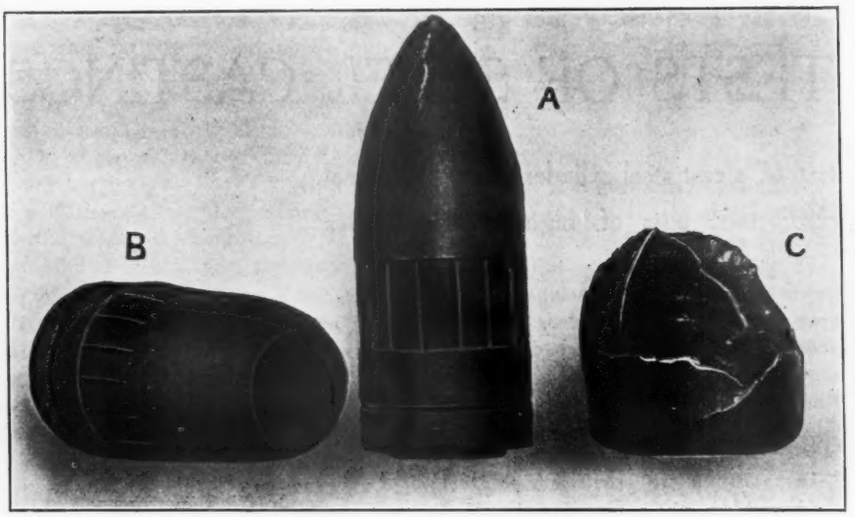


FIG. 3—THE THREE SHELLS AFTER IMPACT WITH THE CYLINDER

shell passed through the steam cylinder at A, another was broken off in the pad at the side of the valve chamber at B, while the third imbedded itself at C. In Fig. 2, the openings made by the shells are more clearly illustrated, and in Fig. 3 the shells are shown after their impact with the casting. Shell A, fired with a charge of three pounds of powder, was 3½ inches long and 1⅜ inches in diameter. It was cracked at the top in passing through the steam cylinder at A, Figs. 1 and 2, but could not again be put through the opening. Shell B was the same size as A and was fired with the same powder charge. The top was broken off and this was removed from the opening B, Figs. 1 and 2. Shell C was 4½ inches long and 1⅞ inches in diameter, and was fired with a powder charge of six pounds. With the exception of the lower part, which was broken off, the shell imbedded itself in the casting at C, Figs. 1 and 2. Neither shells B nor C passed through the casting, nor were any checks developed.

Internal Strains.

This test proved conclusively, that whatever internal strains existed in the casting were removed by the annealing process, notwithstanding the disproportionate thicknesses of the metal in the cylinder. It also set at rest contentions made by many prominent engineers that so difficult a casting as a locomotive cylinder, in which the metal thickness varies greatly, could not be cast in steel.

Hydrostatic Tests.

Interesting hydrostatic tests of cast steel valves intended for high pressure water service have also been made by the Penn Steel Casting & Machine Co. Two, 2½-inch globe valves, 7/16-inch thick, tested to destruction are shown in Fig. 4. The one shown at A burst at 9,900 pounds, while valve B burst at 9,500 pounds. An 8-inch T made of cast steel and annealed, ¾-inch thick, subjected to a hydrostatic test, which burst at 9,500 pounds, is shown in Fig. 5. Specifications, however, called for a test of only 800 pounds. These tests proved conclusively that cast steel is probably a more desirable metal for high pressure service than is ordinarily specified by engineers.

Locomotive Frame.

An annealed, cast steel locomotive frame, one-half of which was almost bent 90 degrees without developing a fracture, is shown in Fig. 7. The frame was rejected by the railroad to which it was shipped on account of sand holes, although a test bar from this heat showed a tensile strength of 68,500 pounds. The carbon was 0.27 per cent. Inasmuch as the frame was to be broken up for remelting in the open-hearth furnaces, it was decided to test it under the drop until broken. The ball of the drop weighed 4,000 pounds and was permitted to fall a distance of 50 feet. The ball was dropped continuously for several hours until the frame was bent as shown, but unfortunately no record was kept of the number of blows.

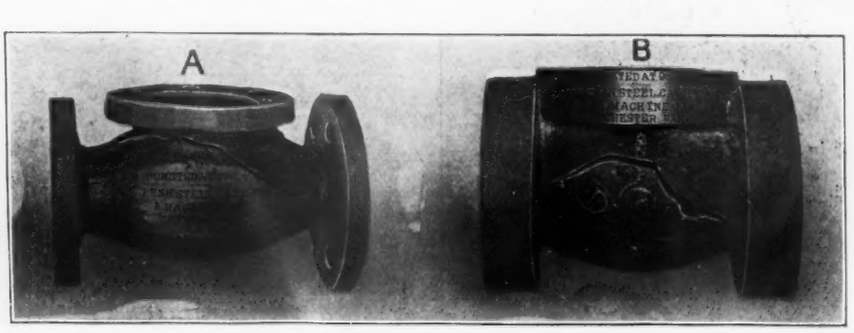


FIG. 4—CAST STEEL VALVES TESTED TO DESTRUCTION

Vanadium in Cast Steel.

This concern has also experimented successfully with vanadium, and uses this alloy in its mixtures whenever specified. The fracture of a cast steel test bar, unannealed, made with vanadium, is shown at B, Fig. 6. It can clearly be seen that it has a much finer grain than the annealed test bar made without vanadium at C. The fracture of the unannealed cast steel test bar, containing no vanadium alloy, is shown at A. The grain is very coarse, and by comparison with C, the good effects of the annealing process are clearly illustrated.

FIG. 5—CAST STEEL TEE WHICH BURST AT 9,500 POUNDS

The vanadium is added in the acid open-hearth furnaces in the proportion of approximately one-fourth of one per cent of the charge which is melted as usual, worked down with ore to about 0.4 per cent carbon, and is "shaken down" for the remainder of the decarbonization. After all of the other alloys have been

added, including the ferro-manganese, the flame is "blanketed" and the vanadium alloy is added in large pieces. About three minutes is required for working through the bath, which is meanwhile rabbled. Tapping and teeming are then performed as usual.

Cast Steel Saddles.

In Fig. 8 are shown two lots of cast steel boiler saddles through which are cold-punched holes, ⅞-inch in diameter. This is a very severe test for any casting, but the loss from this punching operation is very low, inasmuch as the saddles are carefully annealed.

The plant of the Penn Steel Casting & Machine Co. comprises two foundries. No. 1 shown in Figs. 9 and 10, is equipped with three 30-ton acid open-hearth furnaces, is 60 feet wide with 22-foot bays, and is 632 feet long. No. 2 foundry, Fig. 11, is equipped with two, 2-ton converters, and is 200 x 68 feet. The chipping shop, which is built at right angles to the foundries, is 225 feet long and 75 feet wide. The pattern storage is three stories high, 203 x 50 feet. The machine shop is well equipped with tools, electrically driven, and covers an area of 300 x 59 feet.

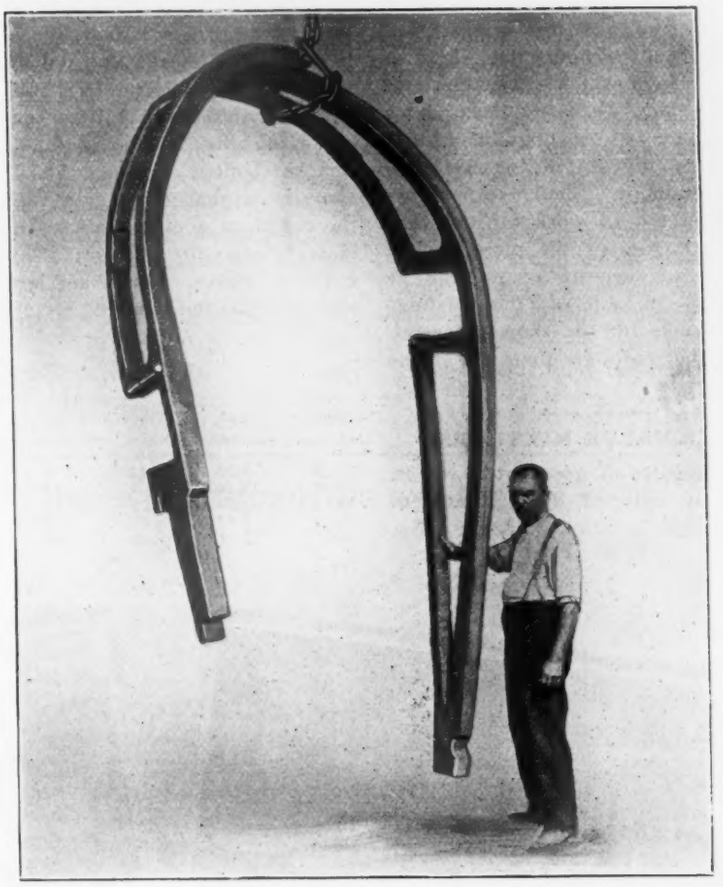


FIG. 7—CAST STEEL LOCOMOTIVE FRAME BENT UNDER THE DROP

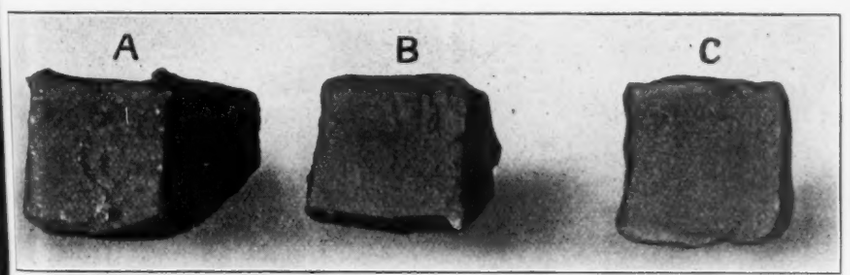


FIG. 6—FRACTURES OF UNANNEALED, VANADIUMIZED AND ANNEALED CAST STEEL

Use of Chills.

In the foundry no chills are used. Hay rope is imbedded in the molds adjacent to the parts of the casting that are to be chilled, and as this burns out while the molds are being dried, it leaves passages through which water is circulated immediately after the mold has been poured. This method of chilling has given very satisfactory results, and obviates all danger of the shifting of the chills ordinarily used in the molds, and which is a source of considerable loss.

Shop Order Blank.

A shop order blank on which is sketched the patterns of castings to be made, together with their dimensions, is shown in Fig. 12. Mimeograph copies of this order are made for each department, and in this way every foreman has a knowledge of the work going through the shop. After the order has been received, a blank is filled out and sent to the pattern shop where the patterns are roughly sketched in the shop order as shown. The dimensions are carefully noted as well as the number of the patterns. Mimeograph copies

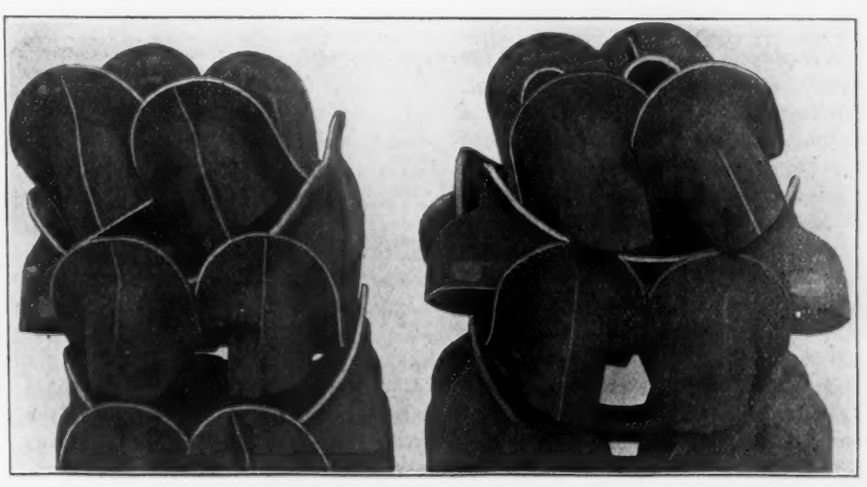


FIG. 8—CAST STEEL BOILER SADDLES

then are made of the original and distributed throughout the shop as noted. The sketches enable the cleaning gang to easily keep track of each lot of castings and they are also readily sorted for the shipping department. Similar orders are also issued for all work for the various departments of the plant and in this way an accurate record can be maintained of all of the castings that are made for the shop, independent of the castings that are made for the trade.

BRASS VALVE MIXTURES.

The requisites of good brass valves, as recently outlined by a prominent manufacturer, are as follows: Resistance to steam, strength, ease of casting and ease of machining. The first requirement is determined by the use of a hardness testing machine. This instrument is substantially a graduated tube in which is placed a definite sized steel weight which drops from a constant level onto the specimen to be tested. The distance of the rebound of this steel weight, as measured on a graduated scale, is an indication of the hardness of the metal. This manufacturer claims that such a hardness testing is a very good indication of the resisting power of the metal to the action of the steam. Unfortunately, no data is available regarding the heat treatment of the metal that is ordinarily cast into valves, inasmuch as there are not more than one or two concerns in the United States that have gathered data on this subject. In Table 1 are given analyses of valves made by some of the leading manufacturers of the United States. The second analysis is that of a gate valve and the fourth of a globe valve. In Table II are given the analyses of various radiator valves, which are used extensively in the United States:

Table I.

Copper, per cent.	Lead, per cent.	Tin, per cent.	Iron, per cent.	Zinc, per cent.
87.28	4.70	7.15	0.27	0.61
76.60	13.16	4.08	0.42	5.74
88.72	2.77	4.25	0.48	3.78
85.33	5.02	4.01	0.42	5.22
89.93	2.99	5.60	0.50	0.98

FIG. 9—FURNACE END OF FOUNDRY NO. 1

FIG. 11—GENERAL VIEW OF SIDE BLOWER CONVERTER DEPARTMENT

FIG. 10—GENERAL VIEW OF FOUNDRY NO. 1

Table II.

Thickness of metal body, inches.	Short diameter of hex., inches.	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, per cent.
6/64	2	87.60	3.63	1.82	6.90
7/64	2	83.59	2.69	6.06	7.93
6/64	2	89.50	4.43	4.22	1.92
9/64	2	78.42	2.86	9.42	9.28
6/64	2	81.60	0.10	6.98	11.09
8/64	2⅛	83.26	2.83	5.57	8.27
7/64	2	80.87	2.19	4.30	12.44
6/64	2⅛	80.59	4.01	5.00	10.18
		77.38	2.69	10.93	9.00

STRENGTH OF CAST IRON.

By W. J. KEEP

Question:—In your circular, "Mechanical Analysis," you state that "the strength of cast iron is not to any great extent dependent upon its chemical composition though phosphorus weakens it." Will you please explain this statement, as I was under the impression you had very conclusively proven that the addition of silicon, thereby changing the combined carbon, changed the strength along with the shrinkage and chill. If this is not the case what is it makes a 25,000-pound tensile strength cast iron differ from a 15,000-pound specimen?

Answer:—With the casting of a given size, an increase of silicon in any brand of cast iron will change combined carbon into graphite. If a brand of cast iron is hard and brittle from combined carbon and consequently weak, by increasing silicon, enough combined carbon is turned into graphite to soften and strengthen the iron by removing brittleness, and this also enlarges the grain. A farther increase of silicon still more enlarges the grain, thereby weakening the casting and incidentally it changes more of the carbon into graphite. The increased silicon at first removed internal strains, but when farther increased it so increased the time of cooling that the central portions of the casting contained spongy spots which weakened the casting.

Slow cooling in such a casting slightly changes combined carbon into graphite and the slower the cooling the coarser the grain and consequently the less strength.

For the strongest casting, therefore, brittleness must be prevented and the iron must freeze or set in the shortest possible time so as to produce a close grain and yet not have the casting too hard.

To produce these qualities in a very small casting which freezes very quickly on account of rapid cooling, the silicon must be high because the combined carbon must be low.

To produce the same qualities in a large casting, on account of its slow cooling, its freezing must be hastened as much as possible. The only practical way to accomplish this is to reduce silicon as low as possible and have the casting machinable. This produces a close uniform grain and prevents sponginess in large castings. With the same brand of iron for strong small castings, the silicon is high and the casting is quickly cooled. For strong large castings the silicon is low and the cooling is necessarily slow.

For the greatest strength for castings of different sizes, the silicon should be varied for each casting inversely as the rate of cooling, but this is impracticable. Slow cooling is the chief cause of a coarse, open and spongy grain and an increase of silicon makes the iron freeze more slowly.

High silicon iron which will make a strong small casting, would make a weak casting from too open a grain, and the low silicon iron which would make a large casting with a close grain would make a hard, brittle and weak small casting.

Strength or weakness is produced by the physical condition of the grain of the iron. The only practical way to influence this physical structure is to vary silicon and rate of cooling. High silicon for small, and low silicon for large castings.

The foregoing applies generally to all iron mixtures, but specifically to the use of a single brand of iron, or a given iron mixture in which silicon is the only variable.

However, one brand of iron will make a stronger casting than another brand and the reason for this will not be explained by any variation in chemical analysis.

The explanation must be that the grains interlock in a different way. Every founder can produce an exceptionally strong iron by varying a mixture independently of the chemical composition. The strength may be increased by some treatment of the iron such as stirring it in the ladle or by pouring at different temperatures, the chemical composition remaining exactly the same.

A founder should experiment with the iron that he can buy to find which can be combined to produce the strongest castings. When he has found this, he can control such a mixture by varying the silicon and can determine the silicon required either by a measure of the shrinkage or by a chemical analysis.

White cast iron which melts at a lower temperature than gray cast iron shrinks most. The low shrinkage of gray cast iron is on account of the open grain. Just after gray iron freezes, the casting swells, and that which swells most has the least shrinkage. As silicon increases the shrinkage decreases, and the iron becomes softer.

By high silicon in the foregoing we mean from 2.50 to 3.50 per cent, and by low silicon from 1.00 to 2.00 per cent. In very large castings the silicon may be below 1.00 per cent and the casting still remain gray and machinable. The shrinkage of a large casting will be less than a small casting from the same iron, because the cooling will be slower and the grain coarser.

The strength of cast iron is more dependent upon the interlocking grain formation than upon any chemical composition, and with the same silicon the strength of a small casting will be inversely as the strength of a large casting.

It is not practical to make a test bar the same size as each casting, therefore, if you control the amount of silicon in a mixture by the measure of shrinkage use one size of test bar all the time, and having formed the shrinkage of this test bar, when your castings are satisfactory, if the shrinkage increases, increase silicon in the next cast, and vice versa.

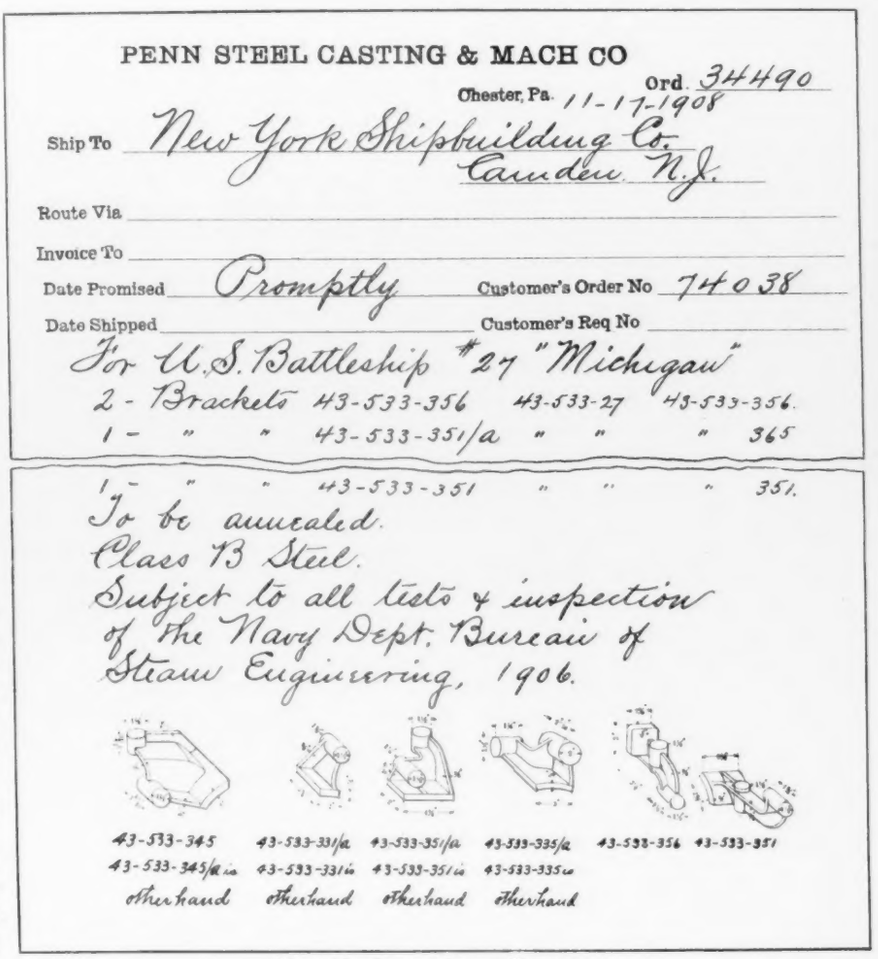
If you employ a chemist he will determine the percentage of silicon in the casting by analysis and if it is lower than standard he will order an increase of silicon.

As a general thing, in small castings, an increase of strength accompanies an increase of silicon, and a decrease of shrinkage, and vice versa.

But in every case, an increase in strength of the mixture increases the strength of small and large castings irrespective of chemical composition.

An exception is made in the case of phosphorus, which has very little influence on strength if below 0.75 per cent, but weakens the iron if above 100 per cent.

Phosphorus causes the iron to remain fluid longer, to freeze at a lower temperature and increases the swell of the casting after it freezes, therefore it decreases the shrinkage of the casting.



PENN STEEL CASTING & MACH CO

Chester, Pa. Ord. 344490

11-17-1908

Ship To New York Shipbuilding Co. Camden N.J.

Route Via

Invoice To

Date Promised Promptly Customer's Order No 74038

Date Shipped Customer's Req No

For U.S. Battleship #27 "Michigan"

2 - Brackets 43-533-356 43-533-27 43-533-356.

1 - " " 43-533-351/a " " " 365

1 - " " 43-533-351 " " " 351.

To be annealed.

Class B Steel.

Subject to all tests & inspection of the Navy Dept. Bureau of Steam Engineering, 1906.

43-533-345 43-533-345/a in otherhand

43-533-331/a 43-533-331/a otherhand

43-533-351/a 43-533-351/a otherhand

43-533-335/a 43-533-335 otherhand

43-533-356 43-533-351

FIG. 12—SHOP ORDER BLANK

THE SAND BLAST IN THE FOUNDRY---IV

Effect of sand and oil on hose used in sand-blasting castings---Nozzles, their size and construction

BY JAMES M. BETTON

ONLY the best qualities of rubber hose, especially made with a thick inner wall of pure rubber, will stand the cutting action of the sand for any length of time. Any grade of hose may be used, but that which is not reinforced internally will not last long. In actual service it will be often found that the wear on the hose is fully as great on the outside as within, due to its being dragged over the rough castings, and if care is taken to prevent this, the life of the hose will be perceptibly lengthened.

The best of hose may be spoiled by the operator kinking it under his arm, a convenient and very destructive way of stopping the flow of air and sand, and the habit should be guarded against. A further rule should be made that the hose be hung up at the end of the day's work on a curved hanger attached to the side wall of the cleaning room.

Effect of Oil in the Hose.

One of the most destructive agents is oil in the air. Many engineer's operating compressors are liable to feed too much oil into the air cylinders under the impression that this lubrication is of advantage to the compressor and to the valves and pistons of the pneumatic tools used in the foundry. As a consequence the air is often thick with particles of oil, and these settling on the inner walls of the hose, chemical action taken place and, in a short time, the smooth, clean rubber surface becomes pitted, soggy and rotten, the sand is retarded, and the hose cuts through in a very short time. A small quantity of oil, fed slowly and at long intervals, will keep the air end of the compressor in good order and not make itself apparent in the hose.

Size of Hose.

The passing of the air and sand through the hose is similar to that in the nozzles, the swiftest current being in the center, flowing through a surrounding annular current of slower velocity, and because of this it is desirable that the diameter of the hose be not too large, especially when a small nozzle is used. In this case it will be found that a portion of the sand will drop, by its own weight, from the outer current to the bottom of the hose, until it accumulates to an extent sufficient to stop the flow temporarily, when the sand will be expelled from the nozzle in a series of gulps until the normal flow is reestablished, when the process begins again. This is especially liable to occur when the delivery hose is allowed to form a pocket. In a hose of smaller diameter the velocity of the air and sand is greater throughout its entire area, less chance occurs for the lodgment of the heavier sand, the flow is even and continuous, for which reasons a smaller hose of proper area is preferable.

The greater velocity of the current may tend to shorten the life of the hose, but it will be found that this is not as serious as it might appear, that the objection is more theoretical than actual, and that it is easier for the operator to handle.

With high air pressures, small nozzles must be used and with them small diameters of hose, to keep the velocity of the current at its maximum and to reduce to the minimum the inner surface of the hose exposed to a heavy pressure of 60 to 100 pounds per square inch, and escape damage from bursting, if the nozzle becomes clogged. Wire bound hose has been used, but while the wire will prevent to some extent external wear, the internal cutting is the same as in the unprotected hose and its life is not much longer. Metallic hose, for which claims of durability have been made, has not been found to stand the cutting action of the sand long enough to warrant its continued use. The hose couplings should be of a simple form, as the shanks, which come in contact with the sand, will wear with more or less rapidity.

Nozzles.

Sand blast nozzles are made in various lengths from 1 to 6 inches, with bores from ¼ to 1 inch, the usual sizes being ¼-inch, ⅜-inch, ½-inch, ¾-inch and 1-inch. Nozzles are made of case-hardened Bessemer steel, white iron, cast iron chilled, gray iron, or special mixtures, but the life of any of these materials is about the same, under the ordinary conditions of use. No two nozzles wear alike, one may last for a day or two longer, while another, from the same lot, will wear out in a few hours or even less.

Efforts have been made to obtain some material that would withstand the abrasive action of the sand, and special mixtures of iron and special alloys have been tried, but their durability has not encouraged their extensive use. Soft materials, such as pure rubber wear equally fast and the material that will stand up to the work is yet to be found.

The majority of foundrymen make their own patterns and cast nozzles from convenient heats of hard iron, using steel cores, properly smoked, which act to a certain extent, as chills. Attempts have been made to produce nozzles designed on calculated curves giving the theoretically correct lines of discharge, but these have proven of no value and have cut out within a few hours.

Size of the Nozzle.

The length of the nozzle is important, for if too long, say over six inches, the side wall is almost sure to cut through at a point about four inches from the inlet.

It will be usually found that a short nozzle is preferable, as it does not afford an opportunity for the current of sand and air to swerve from side to side, whether due to the deflection caused by some rough spot or an almost imperceptible projection, sufficient however to change the course of the current, or to the natural action of this current. The flow of the current through the nozzle is practically the same as that of a jet of water through a tube, there is a central core moving at the greatest velocity through a series of surrounding annular rings moving at speeds, each one slower than the next as they extend from the center of the nozzle, these speeds depending upon the material of the confining walls and the friction therefrom. If the tube were perfect and friction entirely eliminated, each grain of sand would be discharged in a straight line, but any change of direction of flow, any irregularity of inner surface, deflects the particles of sand and air and imparts to them a glancing or ricochet movement which continues through the entire length of the discharge pipe and nozzle

and will account for any extraordinary wear thereof.

Nozzles are made tapering, to allow of their being held in place by a simple screw follower nut on the nozzle holder, which is as satisfactory as making them straight and securing them in the holder by a thumb or set screw, or straight with a projecting ring to rest against the nozzle holder. The perfect nozzle is yet to be found.

HIGH AND LOW PRESSURES FOR THE SAND BLAST.

To the Editor: Referring to the article, "High and Low Pressure for Sand Blast," which appeared in the November number of THE FOUNDRY, I beg to say, that many of the statements contained therein are absolutely incorrect. For instance, it requires approximately 19 horsepower to compress 100 cubic feet of air from atmosphere to 80 pounds pressure, with one-stage compression and about 9½ horsepower to compress the same quantity to 20 pounds pressure and not 15.94 and 6.28 as stated.

As to the relative merits of high and low pressure sand blasts, it seems to me, that the mere fact that all latest machines embody the high pressure principle and furthermore, the fact that some of the low pressure blast manufacturers have started to adopt the high pressure with their machine, is ample proof that the high pressure principle has some decided advantages over that of the low pressure.

According to this article a low pressure blast with a ⅜-inch sand nozzle requires 69 cubic feet of free air per minute, while a high pressure machine, according to the table, requires 191 cubic feet of free air per minute at 80 pounds pressure with a ⅜-inch sand nozzle.

The writer has positive information, obtained from actual tests with one of the latest sand blast machines, that this blast, due to its construction, actually used 77 cubic feet of free air per minute at 80 pounds pressure with a ⅜-inch sand nozzle, and that it did at least 50 per cent more work than a low pressure blast of well known make at 20 per cent pressure and ⅜-inch sand nozzle. It is therefore apparent that the high pressure principle is to be preferred.

According to this article, the low pressure machine in question requires 69 cubic feet of free air per minute at 20 pounds pressure, which according to the data given means 10.99 horsepower since the 69 cubic feet of free air are taken from the shop system at 80 pounds pressure by means of a reducing valve. As a matter of fact it takes almost 13 horsepower to compress this amount of air to 80 pounds pressure, and as the high pressure blast requires 77 cubic feet at 80 pounds pressure or about 14½ horsepower, the extra 1½ horsepower over the low pressure machine will do over 50 per cent more work than the latter.

In addition to the above advantage, the high pressure machine in question is constructed in such a way, that the moisture in the air cannot clog the blast or affect the operation of the machine. Furthermore, there is no sand valve, the sand supply being adjusted by the air valve, which results cannot be obtained in the low pressure, closed hopper type of machines.

A. E. HOERMANN.

To the Editor: In stating the horsepower required to operate sand blasts under different conditions in the article which appeared in the Foundry, November, 1908, the actual dynamic horsepower for one-stage compression was used, being taken from the standard table in a catalog published by the Ingersoll-Rand Co. No allowance was made for friction, as this will vary under different conditions and with different types and sizes of air compressors, 10 to 15 per cent being the allowance given in this table to cover this. In some cases this percentage may be exceeded, and it was deemed advisable to state any work in terms that would represent the minimum. The differences referred to arise simply from such calculations as—15.94 horsepower plus 15 per cent or 2.38=18.32 horsepower, and 6.28 horsepower plus 15 per cent or .93=7.21 horsepower.

The fact that some of the sand blasts recently placed on the market are designed for high pressures is not evidence that high pressures are better than low pressures. Upon investigation it will be found that some of these machines can only be operated under high pressure and depend upon this to create a sufficient vacuum with which to raise the sand. Many of these machines were designed to take advantage of conditions in a large number of foundries where an air pressure of from 80 to 110 pounds is carried to operate pneumatic chippers, rammers, vibrators, etc., and that a loss of power is sustained ordinarily in reducing these pressures to 20 or 30 pounds, usually employed for the sand blast.

There has been no adoption of high pressures by the established makers of sand blasts, all of whose machines will operate under any pressure up to the limit of safety, or that required to burst the tank, and a statement on their part does not imply either their adoption of high pressures or recommendation; on the contrary, it will be found that the majority of them will recommend low pressures when available, because machines of this type will do as much actual work as high pressure machines, with less consumption of power, allow the use of a larger nozzle and a greater range in the grades of sand, make less dust by not shattering the sand, are easier on the operator and are safer.

Let us look into the matter of power used by the air system of a modern foundry using pneumatic tools, assuming that there will be

		cubic feet per minute.	cubic feet.
3	Bench hammers	10	30
2	Floor hammers	17	34
5	Chipping hammers	25	125
6	Vibrators	8	48
2	Motor hoists	45	90
	Total		327

This makes a total of 327 cubic feet of free air per minute under 100 pounds pressure.

The power required to operate these tools will be 3.27×18.15=59.35 horsepower, without allowance for friction.

If a sand blast with a ¼-inch nozzle is used, there will be required 103 cubic feet of free air per minute under 100 pounds pressure, or 1.03×18.15=18.69 horsepower additional, without allowance for friction. If the pressure for the sand blast is reduced from 100 to 20 pounds and a ½-inch nozzle used, 123 cubic feet of free air per minute will be consumed and the power increased by 1.23×18.15=22.32 horsepower, without allowance for friction. But if a separate compressor be installed for a low pressure sand blast, the consumption of air per minute under 20 pounds pressure, which will do the work, with a ½-inch nozzle will be 123 cubic feet and the power, 1.23×6.28=7.72 horsepower, without allowance for friction. The difference in power between that required for a ¼-inch nozzle under 100 pounds will be 18.69—7.72=10.97 horsepower, and between that required for ½-inch nozzle under 100 pounds, reduced to 20 pounds, will be 22.32—7.72=14.60 horsepower.

Figuring the value or cost per horsepower per annum at $50.00, the saving in the first instance will be 10.97×50=$548.50, and in the second, 14.60×50=$730.00, or ample to pay for a separate compressor in the first year, and to constitute a decided source of profit thereafter, these figures, without allowance for friction, being the minimum. Economy of power cannot be overlooked and these facts being presented to the attention of users of sand blasts, actual or prospective, the argument in favor of high pressures will fail to convince.

In past years the sand blast was surrounded by mystery and but little attention was given to it or to its consumption of air, unless the compressor was found to be too small, when some care would be taken to remedy this, but nowadays, when every foundry is reaching out for work and many are taking in whatever they can solicit, outside of their regular established lines, and at prices

that are low, this close competition and fight for existence has forced the subject of economy in power, as well as in labor, to the front, and the sand blast is receiving, in turn, some of the attention it merits.

As to the statement of the saving in air effected by a certain high pressure sand blast, it is well known to makers of these machines that the actual consumption of air is lower than that stated in the standard table of quantities per minute under various pressures and different diameters of nozzles (Cox), but as it is not uncommon for a user to install a compressor of as small a size as he thinks will do his work, and especially as there is from the first minute of operation a constant wear on the nozzle, rapidly increasing its diameter and consequently the quantity of air per minute, it is good judgment to state the amount of air required, substantially that given in the table referred to, without deductions. If this quantity is provided, no complaint will arise, and any extra air is readily utilized.

Statements of the comparative amounts of work done by two machines working under different conditions, while possibly interesting to those making the test, fail in value and are not convincing to the average user for the reason that they do not, as in this instance, state how the quantity of air consumed was found in the one machine, and whether the same care and means to gage the quantity were exercised with the low pressure blast, which would undoubtedly, for the reason above stated, have shown a smaller consumption than that assumed.

The statement of the work done is indefinite, whether the comparison was made in actual square feet of surface cleaned or in number of castings of similar weight and pattern is not given. Very few of such tests prove accurate means of comparison because of this indefiniteness, and further, because in but few foundries the work to be cleaned, means of handling, actual conditions of cleaning and personal equation are similar. J. M. BETTON.

SECOND MEETING OF INSTITUTE OF METALS

THE Institute of Metals, the new association organized in Great Britain to specialize on non-ferrous metals, held its second meeting at the Institution of Mechanical Engineers, Westminster, London, England, January 19 and 20. Sir William White presided, and announced his reelection as president, the vice presidents being, Prof. Gowland, vice Admiral H. J. Oram, H. D. Bonner, of London; H. Cookson, Newcastle-on-Tyne; Sir Gerard Muntz and Sir Henry A. Wiggin, Birmingham. The members of council are: G. A. Boeddicker, J. A. Bayliss, A. E. Seaton, Birmingham; R. K. Gray, J. T. Milton, Prof. T. K. Huntington, E. Ristori, London; J. Corfield, E. Mills, Swansea; G. N. Nisbett, Mr. Prescott, and C. H. Wilson, Sheffield; honorary treasurer, Prof. T. Turner, Birmingham; honorary secretaries, Prof. H. C. H. Carpenter and W. H. Johnson, Manchester.

Prof. Turner read the treasurer's report showing an income of £665 and a balance in hand of £430, subscriptions having been paid by 273 members. The special fund for preliminary expenses had realized £82. A special appeal was made for £200 to cover office expenses, and the balance in hand is to be devoted to the publication of a journal and other objects of the Institute.

The meeting, which was not so numerously attended as the one at Birmingham, was devoted largely to the discussion of papers read at Birmingham, extracts from which have already been published in THE FOUNDRY. An additional paper, however, was presented by Sir Gerard A. Muntz, entitled "The Relation Between Science and Practice and Its Bearing on the Utility of The Institute of Metals." The paper as a whole pleaded for co-operation, declaring that in the non-ferrous metal field the hand of each man was raised against his neighbor. In the future the manufacturer, the scientist and the engineer, should cooperate.

The remaining portion of the three meetings on Tuesday afternoon and evening and Wednesday morning were devoted entirely to the discussion of papers.

The discussion of Sir Gerard Muntz's paper drew forth several expressions of a desire that the work of the technical experts might be made of more practical service.

The Small Brass Founder.

W. H. Johnson, Manchester, speaking on behalf of the small brassfounder, said he represented the class that is unable to have the advantage of a work's laboratory. As aluminum had come forward so marvellously during the past few years they wanted to know how to make use of it to replace either tin or copper, and they had joined the society with the object of increasing their knowledge. What they needed were a few simple facts readily applicable. He hoped that the society would be joined by the smallest brassfounders. It was very essential also to know where information could be found by those who were unable to master a mass of technical details.

An interesting discussion followed on the paper presented by J. T. Milton entitled "Some Points of Interest Concerning Copper and Copper Alloys."

Mr. Seaton said that when making iron and copper castings, time played an important part because of its effect upon the amount of carbon taken up. He thought the excellent quality of bronzes produced by the Peruvians and Egyptians were due to the fact that these people were not in such a hurry, and were solely concerned with getting good material. He could not help thinking that some of the mysterious changes in copper were due to the introduction of sulphur. Even in its purest form, copper contains a considerable amount of sulphur which sometimes renders it "cold short." He added that all foundrymen wanted to know what part aluminum plays in the physical change which makes the difference between tin bronzes and zinc bronzes, the latter being improved by the addition of aluminum, while the former are not. He said that crystallisation plays an important part in the case of large brass castings such as propeller blades, and he was astonished to find how large these crystals are. Many years ago he experimented with lead bronzes and found that the slightest intermixture of lead reduced the strength. Yet lead is very largely used for improving the color and softening bronze. He insisted that brass foundrymen expect too much from what is called "work" in metals. It is essential to cool as rapidly and as evenly as possible to get fineness of crystal and the best strength, and he obtained excellent results by plunging hot metal into oil at a temperature of 300 degrees Fahr., and then dropping it down to actual coldness.

Treatment of Copper.

Prof. Gowland considered that the annealing of copper in a smoky atmosphere was quite sufficient to account in many cases for extreme brittleness. Commercial copper contains oxide of copper, and the smoky flame removes the oxygen in a short time and entirely changes the molecular condition. That is true above all the ordinary temperatures. There is no doubt a definite temperature at which copper could be best annealed, and after that temperature is reached the metal

must be kept for a certain time at that point. Unfortunately, he said that works carrying out very important operations do not use the pyrometer. With regard to the ancient bronzes he found from analysis that they contained all kinds of impurities and their hardness is solely due to hammering. Nobody introduced lead into copper-tin bronzes to secure strength. Lead permits the metal to be cast at a lower temperature. In casting bearings he found that the metals for heavy bearings came out more satisfactorily if they contained from 1 to 2 per cent of zinc. His experiments with an electro-type of copper showed that unsound castings were due to sulphur. The use of a solution of copper-sulpnur accounted for the minute cavities.

Mr. Milton, who briefly replied, said that he had found in many cases, Muntz's metal did not last as well as copper, especially for sheathing. Engineers do not think that metals with large crystals are as reliable as those with small ones. Yet, very many large bronze castings have immense crystals, ⅜-inch across, which give satisfaction and show a great deal of ductility. Brass founders prefer lead because it makes the art of brass founding easier, while engineers put lead into gun metal in the belief that it makes sounder castings. The value of lead is one of the old traditions which is not founded on fact.

Evening Session.

The evening meeting was mainly devoted to the paper by J. T. W. Echevarri on "Aluminum and Some of Its Uses," which yielded a very interesting discussion. Mr. Ristori thought that aluminum, because of its lightness, should be more extensively used in shipbuilding, but many years ago he got an order from the French minister of marine for a propellor to be cast of aluminum-bronze. It was to be 14 feet in diameter. The casting was made, and while it was something like a propellor in appearance it was nothing but a mass of blow-holes, which the marine inspector instantly refused.

Mr. Philip, admiralty chemist, said that there is evidently a large amount of aluminum used in bronzes, and to a considerable extent for propellors. However, he had seen them corrode in the most extraordinary way, and why that corrosion took place was an interesting question for shipbuilders and engineers.

Prof. Turner thought a serious difficulty was the inability to solder aluminum. Mr. Seaton described his experiences in casting aluminum bronze. He wanted strong castings for boiler mountings, but they were so porous that they were useless and would not stand the necessary hydraulic tests. The crystals after working were in a long needle-like form, fairly interlaced and interlocked.

Bronze Propellors.

Mr. Echevarri, replying, said that during the last 18 years he had made a number of aluminum-bronze propellors for admiralities in France and England, and he had never come across a case of corrosion. Aluminum could be rolled in steel mills quite easily. Cast ingots could be rolled to give a tensile strength in plates of 16 to 18 tons per square inch.

The concluding session, Wednesday morning, was mainly devoted to a discussion of the paper by Mr. Philip entitled "Some Notes on Phosphor Bronze."

Prof. Huntington said that the metallographic method of testing phosphor-bronze was sufficiently near the truth for practical purposes, and was as likely to be correct as the analytical method. The most important effect of phosphorus is in the removal of the oxygen.

Mr. Seaton cited instances of the lack of endurance of phosphor bronze bearings on Atlantic steamers and was of the opinion that the best results were obtained when the metal contained only a trace of phosphorus.

DIFFICULTIES WITH A YELLOW BRASS MIXTURE.

Question:—We have just commenced to make brass castings for a large automobile manufacturer, but we are having considerable trouble with our yellow brass mixture. It consists of copper 60, and zinc 40. It is very dark and looks very much like a scrap mixture, although we use ingot copper exclusively. Our zinc is scrap, melted into ingots made from fruit jar tops. Furthermore can you advise us the loss in melting yellow brass, manganese bronze and phosphor bronze?

Answer:—You can improve your mixture by the addition of aluminum, silicon, manganese or iron. Aluminum will strengthen your alloy and will make it run freely. However, it will cause dross in heavy castings if not skillfully handled. Pour as cool as possible and use from five to eight ounces of aluminum to each 100 pounds of metal. Silicon has the same effect as aluminum as it strengthens and imparts fluidity. It, however, does not shrink and run to dross quite as much as aluminum. Never use it in any alloy containing lead. Use from 1 to 2 per cent of 10 per cent silicon-copper. Manganese must be used in alloy with zinc. Melt five pounds of 30 per cent manganese-copper and add gradually nine pounds of ingot zinc. Pour this into ingots and use from 2 to 6 per cent. The castings come out of the sand a pleasing brown color, but if too deep decrease the manganese-zinc. Iron can be used in the form of tin plate, but it is best used in the form of a salt, and unless well versed in the metallurgy of copper-iron alloys, I would not recommend its use, although it gives much better results than any of the elements mentioned when properly used. The loss in melting yellow brass is a variable quantity and may range from 3 to 10 per cent, according to the skill of the melter. When the metal flares furiously, forming zinc oxide crusts on top of the alloy, the loss is high, but using aluminum or silicon the metal should flare but feebly, the loss in consequence being much smaller.

K. K.

ACCIDENTS IN FOUNDRIES.

A preliminary report of the committee appointed at the Toronto convention of the American Foundrymen's Association to investigate accidents in foundries, and to suggest methods of prevention, has been submitted for the consideration of the members of this organization. Letters were sent to all of the foundries in the United States and Canada, and 1084 replies were received. No accidents were reported by 651 foundries, while the remaining 433 reported a total of 5242, eleven of which were fatal and 424 serious. Of the 433 concerns reporting accidents, 345 estimated the cost of the damages at $29,838.42, while one foundry was entirely destroyed. Premiums on accident policies aggregating $48,679.58 were paid by 190 foundries. Many of the letters contained references to safety devices that had been introduced, and these will be referred to in detail in the final report of the committee. A summary of the accidents reported follows:

Accident due to:	Slight	Serious	Fatal	Total No. reporting		Loss
1.—Personal carelessness	1,974	140	4	2,118	123	$10,106 39
2.—Careless work	516	39		555	33	4,643 25
3.—Inattention in shop	227	23		250	19	612 00
4.—Intoxicants	4	3		7	4	33 00
						and 1 foundry
5.—Smoking			1			
6.—Unavoidable accidents	1,547	159	3	1,709	90	6,858 35
7.—Neglect of safety devices	83	7	1	91	9	702 00
8.—Disobedience of orders	79	12	2	93	20	3,531 50
9.—Taking chances	118	24		142	27	2,093 18
10.—Inferior materials used	24	4		28	5	123 25
11.—Employee's ignorance	235	13	1	249	15	1,135 50
Total	4,807	424	11	5,242	345	$29,838 42
						and 1 foundry

MOLDING LOCOMOTIVE CYLINDERS*

Every phase of foundry practice relating to the production of locomotive cylinders is comprehensively discussed--Iron mixtures for hard and soft castings

BY PAUL R. RAMP

MANY improvements have been made in the methods of molding and casting locomotive cylinders in recent years. The use of more powerful locomotives necessitates the use of heavier castings of good quality, and the burden has fallen on the foundryman engaged in this line of work. Dry sand molds should be used and the quality of the sand is almost of as much importance as the iron mixture.

Sand.

An open, gray sand containing some loam that will not require cinders and similar material to carry off the gases should be used. Cinders weaken the mold and permit the castings to swell. The use of sawdust in the facing sand mixture should also be discouraged. Of course, there are undoubtedly localities where the proper sand is not obtainable, yet cinders and sawdust should be avoided wherever possible, as they have a tendency to weaken the mold and the sharp edges are easily broken off while the cores are being set. A good sand mixture for this work consists of 40 parts of open, sharp sand or ordinary gray, building sand, 55 parts of molding sand, such as is used generally for heavy green sand work, and 5 parts of flour. This should be thoroughly mixed and wet with a thin clay wash.

However, the percentage of flour is largely governed by the quality of the molding sand in the mixture. In some cases, where the sand is of such a nature that it will bake very hard on the casting, more flour should be used. The facing sand mixture should contain flour in the proportion of one to 30, or one to 20. If the surface of the mold buckles or scabs the percentage of sharp sand should be increased. This mixture should be made of new material and should be used next to the pattern only, and the balance of the sand can consist of heap sand or other sand that has been used and should be open like the facing mixture. The mistake is frequently made of using a good facing sand next to the pattern, backing this up with a heap sand that is too fine for this work. The patterns should be taken out of the sand the same day the molds are made, inasmuch as they are usually very expensive and swell out of shape when left in the sand too long. With the one exception of cylinders for large compound engines, there are few patterns that must remain in the sand more than a day.

Causes of Defective Cylinders.

There are many reasons why a casting of this kind will crack while cooling or in service; internal strains are the result of irregular thicknesses of metal, molds insufficiently dried, an improper method of casting, the temperature of the metal and the iron mixture. The irregular thickness of the metal is difficult to overcome, inasmuch as it is impossible to reduce many of the heavy parts, although the designer can be of great aid to the foundryman by providing as uniform a thickness of metal as possible. This difficulty can, to some extent, be overcome by the use of chills, by which uniform cooling can be brought about.

Molds Improperly Dried.

A mold not thoroughly dried will generate steam when the mold is poured, and this will permeate the heavier sections which remain liquid longer than the thinner sections. The steam forcing its way through the metal, forms a passage where probably great strength is required, and this usually results in cracking the casting before it has cooled, or shortly after it has been in service. These defects are frequently diagnosed as shrink holes by the foundryman, who

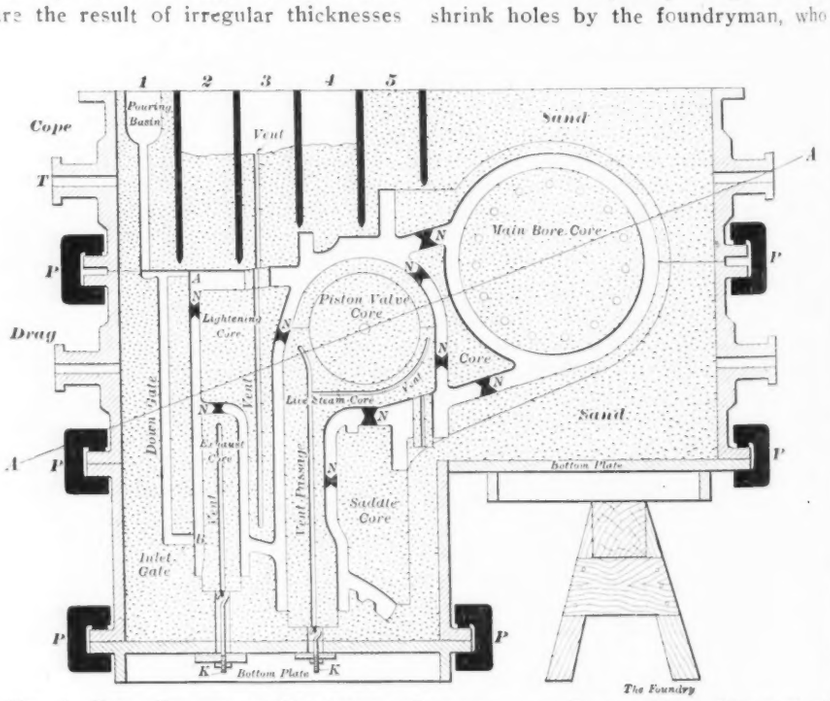


FIG. 1—CROSS-SECTION OF LOCOMOTIVE CYLINDER AND SADDLE MOLD MADE IN AN IRON FLASK

*This article was awarded the prize on steam cylinder practice in the contest conducted by THE FOUNDRY.

ads large feeding heads to overcome the trouble, when, in fact, it is only necessary to thoroughly dry the mold.

The temperature of the metal is of the utmost importance. There is less danger of cracks when the mold is poured with hot metal than when the metal is dull. This difficulty is partly due to the formation of cold-shuts resulting from dull iron. The iron mixture should be given careful attention at all times. The slightest variation in the iron almost invariably results disastrously. Shrink holes can be overcome entirely provided the proper sand is used, and a suitable iron mixture is adopted. Frequently, iron mixtures are changed, when the only difficulty is due to insufficiently dried molds.

Shrink Holes.

An iron mixture high in sulphur and low in silicon may also develop shrink holes. In such cases, iron high in manganese will eliminate the sulphur and reduce the shrinkage provided the iron is cast hot. The method of feeding the risers on cylinder castings may also in a way affect the shrinkage. However, if the proper sand mixture is used for making the cores and the mold, and if the flask is properly constructed as shown in Fig. 1, the feeding of risers can be eliminated, as the expansion of the mold and the cores will control the shrinkage. In such cases it is advisable to chill the risers as soon as the mold is poured to prevent the expansion of the cores from forcing the molten metal out of the mold through the sink-heads. The molds should be rammed hard, the harder the better. A heavy fin is unnecessary if the flasks are properly constructed.

Flasks.

Too many foundrymen try to increase their profits by using flasks that are not sufficiently strong for these heavy molds, and many that are used resemble crates or baskets, and are entirely unsuited for the work for which they are intended. In Fig. 1 is shown a properly constructed flask provided with heavy trunnions and flanges. All of the trunnions are cored as shown at T, and this frequently prevents a fracture in this part of the trunnions, resulting from shrink holes when this piece is cast. All molds should be clamped rather than bolted together, and the clamps in position are shown at P. Clamping is preferred to bolting because it is easier to determine how tight the mold is being clamped when clamps and wedges are used than when bolts are being drawn up. A heavy flask will also overcome the straining of the casting.

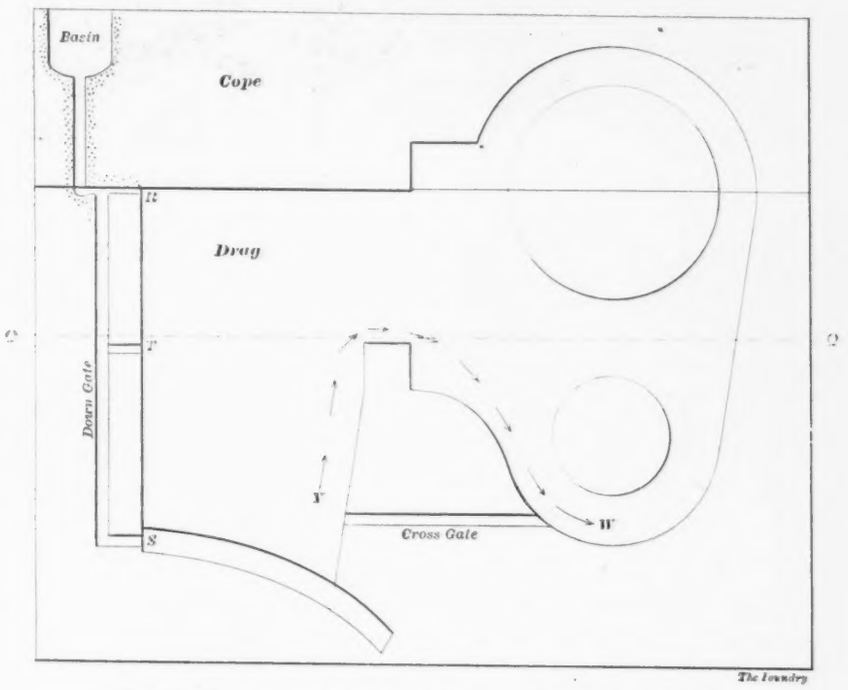


FIG. 3—METHOD OF GATING TO AVOID A CRACKED STEEL PIPE

The Mold.

A cross section of a locomotive cylinder mold ready for casting is shown in Fig. 1. The saddle core simplifies the molding operation by overcoming the necessity of using a three-part flask in which cylinders are generally molded. A portion of the exhaust core as well as the live steam and the lightening cores are also shown. The exhaust, live steam and port cores are made to fit around a piston valve core. These cores are held in position by the use of cast iron anchors, with the exception of the lower end of the exhaust and live steam cores, which are secured by wrought iron core hooks extending through the bottom plates. The vent openings for the exhaust and steam cores are carried through the bottom plate, while the vents from

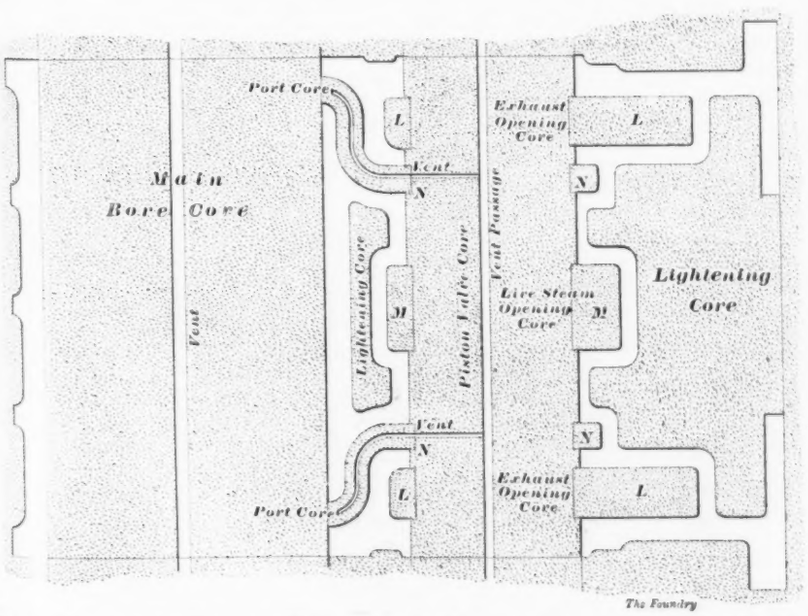


FIG. 4—SECTION OF CYLINDER MOLD AT A A, FIG. 1. THIS ALSO SHOWS THE LOCATION OF THE CORES IN THE MOLD

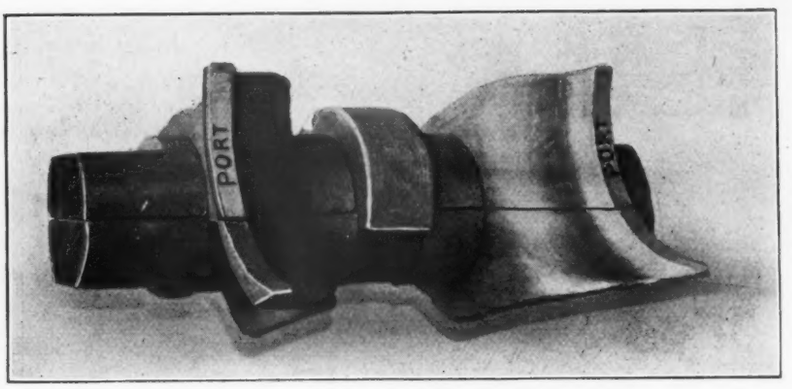


FIG. 4—PISTON VALVE CORE WITH PORT CORES ATTACHED

the lightening cores are carried through the cope. The vents from the port cores are connected with the main vent passage in the piston valve core, as shown in Fig. 2. The connection between the steam and exhaust cores with the valve core is also shown.

The Cores.

The production of the cores for these molds should be given careful attention. The port cores are dried in iron forms, while the exhaust cores are dried on iron plates to hold them in shape. Great economies can be effected by the use of these irregular shaped core plates for all of the cores that do not have one flat surface. When these plates are used there is little complaint from the variations in the thickness of the metal in the casting. All cores should be provided with vent passages, and the practice of using cinders for venting purposes is not to be recommended. Cinders are not nearly as reliable as large vent passages formed by rods or ropes and the cores are stronger when the latter method of venting is practiced.

A piston valve core with the port cores attached is shown in Fig. 4. Great care should be exercised in connecting the vent passages of these cores or a barrel containing sand and slag will result. The various sections of the core that form the exhaust passage are shown in Fig. 5, and in Fig. 6 the exhaust core is shown assembled. The live steam core is shown in Fig. 7, as well as one-half of the exhaust core. The steam core is shown at A and the exhaust core at B. The two lightening cores that cut out the space behind the steam and valve cores, and in front of the lower portion of the exhaust core, are shown in Fig. 8. The saddle core in two sections is shown in Fig. 9. This core does not require much venting, but aids greatly in simplifying the molding problem. One of these castings ready for shipment is shown in Fig. 10.

Setting the Cores.

In setting these cores in the mold it is good practice to use a cheap grade of putty to form the joints between the cores and the mold in the prints. Putty is better than clay and by its use the danger of scum and sand in the castings is obviated. The molten iron also lies quietly against the putty. A loud roaring of the vents when one of these molds is being cast is an indication that the cores were not sufficiently dried, or that the sand from which they were made is too close. This should be remedied at once to prevent the further production of defective castings.

Gates and Runner.

The method of gating the mold is clearly shown in Fig. 1. The cope half of the flask is made deeper than necessary to provide space for making the pouring basin in dry sand shown at 1. The spaces marked 2, 3 and 4 between the bars in the cope are not rammed full of sand. This plan is much better than cutting down the depth of the cope at these points and building on a green sand pouring basin. It obviates the danger of getting sand into the gates and reduces the labor required in assembling the mold for casting. The gate arrangement shows the gate from the basin to the down-gate, and an inlet is cut into the mold at A. This gate is used to liven up the metal over the barrel core. At the lower end of the down-gate the inlet B is made much larger than the gate A. This is done to force most of the metal to flow into the mold at this point. The various cores act as skimmers of the iron before it reaches the more important sections of the molds. Risers are used at the highest points of the flanges. No flow-off gate is provided as this is not considered good practice. If the iron will not lay to the mold without the use of a flow-off gate, which is an unnecessary expense, the sand from which the mold and cores is made is not of the proper quality. The method of gating a cylinder mold depends upon the design entirely, and if this is not carefully considered, trouble will ensue.

Piston Valve Cylinder.

An outline of a piston valve cylinder in a flask is shown in Fig. 3. A cylinder of this type, if gated, as shown in Fig. 1, will develop cracks in the steam and exhaust openings at QQ. This is the result of the metal flowing into the mold at S and when the mold is filled to the level shown at QQ, it remains at this height while the additional metal flows in the direction indicated by the arrows to W, and until this part of the mold is filled to the line QQ. While this metal is inactive on the gate side, a crust forms over it and when the parts of the mold shown at Y and W are filled to the level shown at QQ, the metal

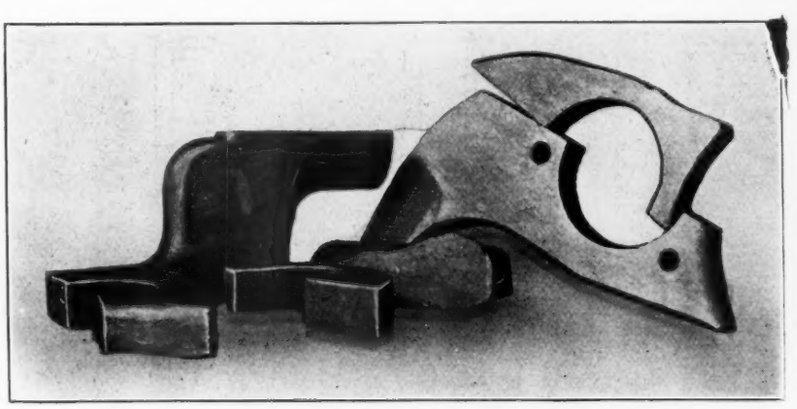


FIG. 5—VARIOUS CORES THAT FORM THE EXHAUST PASSAGE

FIG. 6—ASSEMBLED EXHAUST CORE

begins to rise uniformly throughout the mold and it frequently fails to raise this crust with it, which causes a cold-shut at this point, which later develops into a crack. To overcome this difficulty a cross gate should be used as shown in Fig. 3, which leads directly from the barrel to the saddle section of the casting. This causes the metal to rise uniformly in the mold. The inlet gates are indicated by R, T and S. The gate T is used to liven the metal at this point.

Iron Mixtures.

The iron mixtures used for these castings depend largely upon the specifications of the railroads. Some demand a hard cylinder with a high tensile strength, while others specify softer castings and use a hard bushing. For the foundryman the latter plan is more satisfactory, nevertheless, every foundry engaged in this line of work must be in position to produce castings according to specifications.

For hard cylinders the following mixture has given excellent satisfaction: Wharton pig iron, 1,300 pounds; Shenandoah pig iron, 200 pounds; cylinder scrap, 500 pounds. This mixture, if properly melted, will produce iron having a tensile strength of 32,000 to 34,000 pounds per square inch, and the shrinkage will average 0.28 in two feet. The mixture will show approximately the following analysis: Silicon, 1.60 per cent; sulphur, 0.145 per cent; phosphorus, 0.770 per cent and manganese, 0.351 per cent.

The brands of iron mentioned above are not absolutely necessary for the production of the proper mixture. A soft pig iron together with 10 per cent of steel scrap, 10 per cent of car wheels and 25 per cent of scrap cylinders will also give satisfaction, although the analysis should approximate the one given as nearly as possible. A No. 4 charcoal pig iron can be used to advantage in this work. Charcoal pig iron No. 1 will, to a large extent, obviate the danger of cracks caused by the irregular thicknesses of metal. Pig iron, high in manganese has frequently overcome the cracking of these cylinders when all other mediums failed.

More trouble is experienced from cracks by internal strains where a high tensile strength and a hard wearing surface are specified. Great care should be exercised in the selection of iron for this mixture.

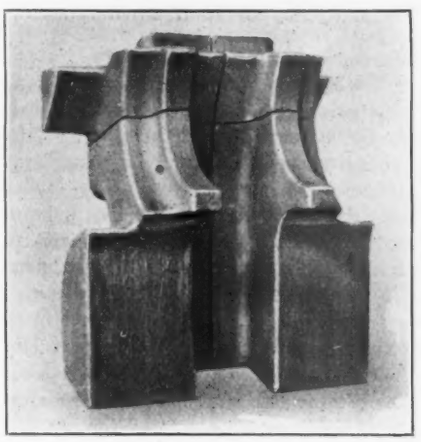


FIG. 8—THE LIGHTENING CORES

FIG. 7—LIVE STEAM CHEST CORE AND ONE-HALF OF THE EXHAUST CORE

Mixture for Soft Cylinders.

For making soft cylinders the following mixture will give good results: No. 2, charcoal pig iron, 400 pounds; No. 1, Hamilton pig iron, 400 pounds; No. 1, Dayton pig iron, 400 pounds; No. 1, Ashland pig iron, 8 per cent silicon, 100 pounds and cylinder scrap, 1,200 pounds. It is good practice when only one cylinder of this kind is made per day to charge the cylinder mixture into the cupola during the first part of the heat to prevent its mixture with the other iron in the furnace.

The practice of making steam cylinders outlined is the result of 28 years' experience in this line of work. Throughout that period the number of defective castings has not exceeded one cylinder every three years.

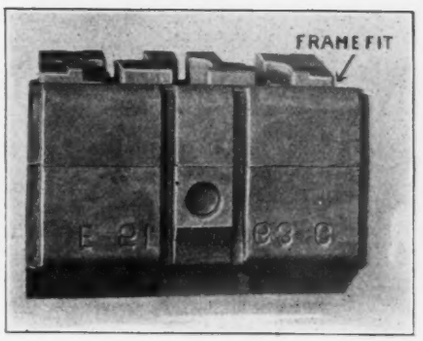


FIG. 9—THE SADDLE CORE MADE IN TWO SECTIONS

The Berry Foundry & Mfg. Co., St. Joseph, Mo., has recently made extensive additions to its equipment and has installed an overhead track system equipped with an electrically operated trolley and hoist made by the Northern Engineering Works, Detroit.

FIG. 10—LOCOMOTIVE CYLINDER READY FOR SHIPMENT

MANUFACTURE OF STEEL FOR CASTINGS*

The open-hearth acid and basic furnaces compared with the side-blow converter and crucible processes

BY BRADLEY STOUGHTON

THE United States contains about 170 active foundries devoted to the manufacture of steel castings, not including other steel plants where castings are occasionally produced, incidental to their regular business. Of these 170, about 101 make open-hearth castings, 43 make Bessemer converter castings, and 45 make crucible steel castings, while the number of furnaces of the different kinds are, acid open-hearth, about 85; basic open-hearth, about 90; converters, the producing equivalent of about 27[1], and crucible melting pots about 750. The tonnage of the different kinds of steel produced in 1904 and 1907 is shown in Table I, from which we see that even the astonishing percentage increase in the production of total castings is less significant than the increase in castings made by the basic process. This condition of affairs is too well known to require more than a passing mention, and is reflected in the production of steel for purposes other than castings, as shown by Table II. In short, it is now recognized that the growing scarcity of low-phosphorus ores, in comparison to the ever-increasing demand for them, is rapidly forcing upon all the steel manufacturers of this country the only process available to them for the reduction of phosphorus. Whether this circumstance is or is not a benefit to the steel casting industry is one of the objects of this paper to study.

Acid Open-Hearth Process.

The distinguishing features of the acid open hearth process are:

1.—An acid slag, small in amount and tenacious of oxygen.
2.—Melting a large proportion of steel scrap with the charge.
3.—Recarburization may be effected in the furnace.
4.—For the sake of economy its operation must be continuous.
5.—Its flexibility in chemical composition of product is small.
6.—Its flexibility in tonnage produced is small.
7.—The waste of metal during melting and conversion is small.
8.—The temperature of the furnace lining will always be hotter than that of the metal.
9.—Its fuel economy is greater than any process except the Bessemer.
10.—The time of melting and conversion is long, 7 hours.
11.—The continuous campaign of a furnace is long, 1,000 heats.
12.—The cost of a furnace is large, $12,500 to $30,000.
13.—Its cost for operation is less than any except the basic.
14.—The liability of blow holes in the product is greater than that of any process except the basic.
15.—The quality of its castings in other respects is higher than that of any process except the crucible.

These characteristics are summarized with those of the other processes in Table IV.

Efficiency of Acid Open-Hearth Process.

The small proportion of slag makes the acid process more efficient than the basic in the utilization of the heat of its flame, wherefore melting is more rapid, a larger proportion of steel scrap can be used in the charge, heats are shorter and fuel economy is promoted. Furthermore, the acid slag, with its lower content of metallic oxides, especially those of iron, is much less liable to leave the steel in the oxidized condition which produces blow holes. Nevertheless, the tendency which competition has brought upon the majority of acid casting plants of forcing their heats by reducing the amount of pig iron in the charge and increasing the additions of ore, does much to counteract this desirable condition, and still further harm results when steel scrap in small sizes is used or the charge melts cold. The cause of greater cost of operation in the acid than in the basic open-hearth process is the necessity for purchasing purer materials for the charge, while its economy as compared to the converter process is due to the lesser waste of metal.

Basic Open-Hearth Process.

These characteristics also are summarized in Table IV, and comprise:

1.—A basic slag, large in amount and an energetic oxidizer.
2.—The use of a large proportion of pig iron in the charge.
3.—Inability to recarburize in the furnace.
4.—Necessity for continuous operation.
5.—Small flexibility in composition of product.
6.—Small flexibility in tonnage.
7.—Relatively small waste as compared to the converters.
8.—Production of high temperatures only at increased damage to the furnace lining.
9.—Less economical of fuel than any process except the crucible.
10.—Slower in operation than any process.
11.—Necessity for frequent cooling down for repairs, 350 heats.
12.—The most costly furnace of all to build.
13.—The cheapest of all to operate when the amount of production is large.
14.—The most liable of any to produce unsound steel.
15.—The quality of its product in other respects is medium.

The basic slag runs 45 to 55 per cent of metallic oxides, of which nearly one-half is oxide of iron. The danger of over-oxidation of the bath thus produced renders it wise to use a larger proportion of pig iron in the charge, which is also demanded by the inefficiency of the furnace as a melter. The more impure the charge in phosphorus, the easier is it melted, but the same conditions also result in a more bulky slag and a longer time for purification, which more than counterbalance any fuel economy hoped for on this account. Add to the labor and fuel charges, the costliness and frequency of its repairs, and we have the chief items of expense of this process, but the use of impure, cheap raw materials makes it nevertheless the cheapest process in America for making steel for castings on a large scale. On the other hand, the quality of basic castings is the lowest of all, due especially to its liability to blow holes, and to the other conditions which have resulted in prejudice against basic steel for all purposes.

Converter Process.

The characteristics of the converter process may be summed up as follows:

1.—An acid slag, small in amount and tenacious of oxygen.
2.—The use of practically no bought steel scrap.
3.—Can recarburize as desired.
4.—May be operated continuously or intermittently.
5.—Great flexibility in composition.
6.—Great flexibility in production.
7.—Waste of metal is very large, one to 20 per cent.
8.—Can produce hotter steel without great damage to furnace.
9.—Fuel economy is greatest of all.
10.—Time of operation is shortest of all.
11.—Campaign is variable, depending on design, 20 to 100 heats.
12.—The least costly to install for a given tonnage.
13.—The most costly to operate except crucible.
14.—The least liable to blow holes in product except crucible.
15.—The quality of castings in other respects is good.

Efficiency of Converter Process.

The converter slag is the ideal one for avoiding over-oxidation of the metal, with the consequent danger of blow holes and other attendant evils, because it is not only small in amount and low in oxides of iron, but is not used for the purpose of oxidizing the impurities in the metal and is therefore less liable to oxidize the

*Presented at the February meeting of the Philadelphia Foundrymen's Association.

[1]The actual number of active converters is close to 60, but the majority of these are not capable of continuous production.

metal itself, especially since no highly-oxidizing materials are added to it and all its metallic oxides come from the bath itself. This is no doubt an important cause of the common observation that converter castings are the least liable to blow holes. A contributory cause is probably the higher temperature of the converter metal at the end of the operation, while the necessity of using only a small amount of steel scrap with the charge removes another danger of over-oxidation.

Opposed to these favorable conditions are the rapid oxidation of the process and the large amount of iron burned to oxide; not nearly so large, however, nor so highly oxidized, as that added to the acid and basic open-hearth processes. The recarburizing conditions in converter practice are also favorable to soundness, because the recarburizer is added to the metal in a hotter condition, whence a better reaction is likely to occur, and because it is added to the bath in the furnace. The operation here is only next in efficiency to the familiar and effective "killing" in the crucible process, since the charge is often retained in the converter for some time after the operation is ended, while small lots of steel are poured out at intervals. As compared with basic metal, the product of the converter has two additional advantages, namely: a higher and more uniform content of silicon in the steel, and no danger of re-phosphorization. Basic open-hearth steel has in its favor the advantage of lower phosphorus. Some tests of steel castings made by all the processes here discussed are given in Table III.

Cost of Converter Plant.

The most important consideration leading to the installation of so many converter plants is doubtless the low cost of the apparatus. One converter costs about $1,500 or $1,700. If the converter is made with fixed bottom, however, it requires three of them of two-tons size to approximately equal in capacity a one or 20-ton open-hearth furnace, because each converter can operate only every third day as a rule, on account of the time required for repairs. The cost of such an equipment will be:

Converters and lining	$5,000
Blower with motor	2,000
Cupolas and linings	950
	$7,950

One two-ton converter with one spare interchangeable bottom would have equal capacity and would cost:

Converter and lining	$1,650
Spare bottom	375
Blower with motor	2,000
Cupolas and linings	650
	$4,975

A crucible steel plant of equal capacity would cost several times as much, although it is to be observed that, where tonnage is no object, a small capacity can be obtained in crucible furnaces at the lowest figure of all.

The Crucible Process.

The crucible process is a remelting, and not a purification process, and employs wrought iron or steel scrap as charge, instead of pig iron. It can be operated intermittently, without considerable additional expense and has corresponding flexibility in product, but its flexibility in chemical composition is limited by the uncertainty as to its content of carbon and silicon. It can produce steel as hot as desired and the quality of its product is the highest of all the processes. It does not require a long, special training on the part of those who are to operate it. but the labor involved is large and costly and this item, together with the costs for crucibles and fuel, make it the most expensive of the processes. To make large quantities of steel, it is also costly to install, but, where tonnage is no object, a small daily capacity may be obtained with the expenditure of a few hundred dollars.

Table I.

Steel Castings and Total Steel Produced in the United States.

	1904. Tons.	1907. Tons.	Increase. Per cent.
Acid open-hearth castings	203,915	379,401	86
Basic open-hearth castings	98,919	366,476	270
Bessemer converter castings	16,051	33,300	107
Crucible castings (estimated)	3,000	6,000	...
Total steel castings.	321,885	785,177	146
Total steel, all kinds	13,859,887	23,359,637	70

Table II.

Production of Acid and Basic Steel in the United States.

	1904. Tons.	1907. Tons.	Increase. Per cent.
Acid open-hearth	801,299	1,269,773	58
Basic open-hearth	5,106,867	10,279,315	101
Bessemer converter	7,859,440	11,667,549	48
Crucible	92,581	143,000	55
Totals	13,859,887	23,359,637	70

New Tropenas Process.

In order to obtain some of this advantage of a small capacity at very low cost two recent innovations in practice have been made. The first of these is the new Tropenas baby converter, in which the necessary heat is obtained by adding at a certain period of the blow, manganese or silicon, whose combustion will give a solid oxide instead of a gas. This process was described in THE FOUNDRY, February, 1909.

Baby Open-Hearth Furnace.

The most recent innovation in the way of a low-priced installation for small capacity, is the baby regenerative furnace erected for an eastern steel foundry by W. M. Carr, described in THE FOUNDRY, January, 1909. To the brief notes already published on this furnace Mr. Carr has kindly added much information, and as this is now made public for the first time, it seems only just to Mr. Carr that I make this acknowledgment of his competent authority for the following statements and disclaim any responsibility on my own part. The first furnace erected is only 350 to 500 pounds capacity and less than 7 feet long. Mr. Carr quotes the following capacities and prices:

Pounds Capacity.	Furnace cost less than
500	$1,000
1,000	1,500
1,500	1,700
2,000	2,100
4,000	3,300

The furnace is acid-lined and built of the rolling type and detachable from the ports. It is arranged so that a stopper can be inserted through the charging door and fitted into the tap hole, thus controlling the flow of metal, whereby molds can be poured directly from the furnace, to which they are brought, or the body of the furnace can be carried by a crane to the molds. His experience with the furnace leads him to state that steel casting heats from 70 per cent steel and 30 per cent pig can be made in 1¾ hours, or four heats in a working day. This result he ascribes to the concentration of the heat in small space, and its easy regulation and control when oil is used as fuel, and he says that a ton of steel is melted with 20 gallons of oil, instead of 40 gallons, as in the ordinary open-hearth, and that the metal is amply hot for thin castings, having a temperature of 1,700 to 1,750 degrees Cent., which is some 100 degrees hotter than the product of the larger open-hearth furnaces.

Operating Costs.

This little furnace is lined with refractory clay bricks, instead of the silica bricks usually employed, and this circumstance, together with its small dimensions, is given by Mr. Carr as the reasons why he can operate it intermittently without excessive damage to roof and walls. He does not recommend a furnace as small as 500 pounds capacity for commercial purposes, but gives the following estimate of costs for one of 1,000 pounds:

Production, 4 heats per working day = 4,000 pounds. Loss, 5 per cent.		
Pig iron, 1,260 pounds at $20 per ton	$11.25	
Steel scrap, 2,940 pounds at $18 per ton	23.62	
Total, 4,200 pounds		$34.87
Deoxidizers		2.25
Labor—Melter	$ 4.00	
Helper	1.50	
		5.50
Fuel, 88 gallons at 3 cents per gallon		2.64
Total cost, two tons production		$45.26

Cost per ton $22.63, or $0.0113 per pound.

The cost for repairs is not included in

those above, because Mr. Carr says this will vary with different conditions, but will never be large as the body of the furnace is the only part that suffers and this is detachable and can be replaced and repaired very cheaply.

Table III.

Averages of Several Results in Each Case.

	Tensile strength.	Elastic limit.	Elongation in 2 inches. Per cent.	Reduction of area. Per cent.
Converter steel...	68,384	.....	31.8	44.9
Converter steel...	67,337	36,263	33.0	42.8
Open-hearth steel.	72,644	39,066	24.6	33.9
Open-hearth steel.	67,633	30,900	28.9	47.1
Crucible steel....	78,267	56,600	19.7	40.0

Robert Converter.

The first of the modern steel casting converters to be developed was the Robert, about 1882. This type has had a long and successful period in France; both the acid and basic processes having been employed. The loss was oftentimes moderate, 15 per cent, but, like all of these side blow converters, if not handled just right, the practice was liable to be wild. Mr. Bookwalter handled the Robert converters in this country and, at one time, as many as 14 were in operation. But the period of their installation, just at the beginning of 1893, was an unfortunate time and they rapidly dropped off, so that only two of the original installations have remained in operation to the present time, to which one has been added since. These failures however, were due more to adverse conditions than to any defects in the apparatus and, from its history in its own country, we find no such cause to condemn this type as our experience here might imply.

Tropenas Converter.

In point of time the Tropenas converter followed that of Robert. Its form and appearance is too well known to require more than a reference here, as about 25 of them are in successful operation in this country. It was originally planned to blow through two rows of tuyeres on the side, but, if we are correctly informed, most of the operators at present prefer to use only the lower row, because observation of the temperature of the steel and chemical analysis of the gases has shown that the upper row is not necessary. Mr. Tropenas, by his scientific attainments and technical organization has contributed to the small steel casting industry of this country more benefit than any other man, and, now that the industry is well established and there are many men all over the land who owe their original experience directly or indirectly to him, it is a pleasure to acknowledge the debt to the one who first had the courage, the ability and the foresight to develop the necessary system of supplying the technical knowledge required to bring this industry to the high plane which it now occupies.

Zenzes and Fisher Converters.

Two each of the Zenzes and Fisher types of converters are in use in this country, but neither of them involve any original features of design or operation so far as has been made evident. It is said however, that those who operate the Zenzes process melt in the cupolas a charge consisting entirely of steel and then, after certain additions are made to it, use this metal for blowing.

Table IV.

Characterization of the Different Processes of Making Steel for Castings.

	Acid open-hearth.	Basic open-hearth.	Converter.	Crucible.
Purification is	Acid.	Basic.	Acid.	.....
Amount of slag, per cent.	6 to 15	15 to 30	10 to 11	.....
Steel scrap used, per cent.	85	50	25	.....
Recarburize	In furnace.	In ladle.	In furnace.	.....
Can be operated	Continuously.	Continuously.	Intermittently.	Intermittently.
Flexibility in analysis	Small.	Small.	Great.	Great.
Flexibility in composition	Small.	Small.	Great.	Small.
Metal loss, per cent.	3	5	15 to 30	1 to 2
Metal or furnace hotter?	Furnace.	Furnace.	Metal.	Furnace.
Fuel used, per cent.	25	30	15	125
Time of conversion	7 hr.	8 hr.	20 min.	4 hr.
Campaign in heats	1,000	350	20 to 1,000	Several thousand.
Cost of installation	Large.	Largest.	Small.	Smallest.
Cost of operation	Medium.	Smallest.	Small.	Largest.
Danger of blow holes	Medium.	Greatest.	Small.	Least.
Quality of castings	Second.	Lower.	Lower.	Best.

Removable Bottom Converter.

Complaint is often made against all these small converters that, when the tuyeres are worn out, which occurs at the end of 25 to 30 blows at most, the vessels must be cooled down and go out of commission entirely until repairs are made, when they must be re-heated in order to be ready for further operations.

This involves the necessity of the plant lying idle part of the time and repairs are made with difficulty in the confined space, besides usually requiring a hole to be cut through the side of the vessel, which must afterwards be replaced and dried, with all the extra delay and cost. It would seem that the simple expedient of taking off the bottom, which has long been recognized as indispensable in standard Bessemer practice, would prove equally advantageous here, and I believe that it does. It enables one vessel body, which lasts for at least 1,000 weeks, to be continuously served in turn by each of two spare bottoms, and gives the utmost economy and rapidity in making repairs. There are now five converters of this type in successful operation in this country, and we may add that an installation made three years ago was built and operated under a guarantee that the loss in cupola and converter should not exceed 15 per cent altogether.

ALLOYS FOR MACHINE BEARINGS.

There was a large attendance at the meeting of the Staffordshire Iron and Steel Institute held at Dudley, Eng., on Jan. 30, when A. Hague, a distinguished student of the Birmingham University, lectured on "Bearing Metals." Considerable practical interest was manifested in the subject, with which the lecturer dealt very comprehensively. He considered separately the rigid bronzes, plastic white metals (or so-called anti-friction alloys), and the plastic bronzes.

Dealing with the first series he said the bronzes were notoriously difficult to cast, and it was a general practice to alloy one to two per cent of zinc in them for the purpose of getting better castings. It probably acted as a deoxidizer. The admiralty gun-metal having a composition of 88 per cent copper, 10 per cent tin, and 2 per cent zinc, is the alloy adopted in the new Birmingham university power station, where it is used alone for small, unimportant bearings, and with a white metal lining for all important ones. Bearings high in zinc do not wear well. The introduction of phosphorus as a deoxidizer showed a decided improvement, and closer grained, harder, and more homogeneous castings were obtained. Silicon is also used for the same purpose. Zinc, although mildly deoxidizing, does not produce the same drastic effects as the more powerful reducing agents. As all old bearings are remelted when worn, and with small additions used for making new bearings, it has become the practice to introduce a good excess of phosphorus, even up to one or two per cent, as a sort of reserve supply. It was thought this would be gradually utilized in subsequent remeltings. These alloys, however, gave very bad results and it was found on investigation that the phosphorus did not appreciably decrease, and that although in the first casting the phosphorus was evenly held by the metal, it had formed a stable phosphide, and on remelting, this segregated together to form bunches of very hard crystals throughout the al-

loy which badly cut into the journal and caused excessive heating. Therefore, all excess of phosphorus or silicon retained by the metal should be avoided.

Dealing with the casting of white metal bearings, the lecturer said that according to one authority the casting temperature should be nearer the melting point of zinc. It should not be higher, as it is liable to oxidize. By casting around the core the metal was chilled, and too great a proportion of the hardening constituent was held in the matrix; the hard grains were much fewer and smaller in size.

Chilled casting is not to be recommended though it is often resorted to by manufacturers to give a fine grained ingot. It brings the matrix which, though stiffer, is still comparatively soft, too much into play as the actual bearing constituent. Metals which had been chilled in casting had proved very troublesome in practice as had also metals which had been cooled too slowly, either from casting from too high a temperature or from the core being too warm. In this last case the cubes are abnormally big and owing to the slow rate of cooling a sort of segregation of the lighter cubes from the heavier matrix took place.

The lecturer dealt very briefly with the plastic bronzes recently introduced in America, and very extensively used there, more especially for railway purposes. The white metal lined bearings, he said, although they had superseded the old rigid bronzes, appeared to have a new rival in the new plastic bronzes. The lecturer, however, took exception to the statement that the low mileage of English truck axles was due to the use of white metal. He had received letters from the English railway companies in which the low mileage was denied. On the contrary the company stated that good steel axles in these bearings wore longer than it was desirable to let the steel run.

PREPARATIONS FOR THE FOUNDRYMEN'S CONVENTION

FOUNDRYMEN and manufacturers of foundry supplies and equipment are already manifesting considerable interest in the convention which will be held in Cincinnati the week of May 17-22, and owing to the central location of the city it is estimated that the attendance will exceed that of any other meeting.

The Cincinnati foundrymen have already organized and are making preparations for the reception and entertainment of the visitors. It has been practically decided to hold a general reception, probably at the Hotel Sinton, on Tuesday evening, which will be known as "get together night." On Thursday afternoon and evening a boat ride on the Ohio river has been planned to a Kentucky pleasure resort where a barbecue will be held.

Local Organization.

An organization of the Cincinnati foundrymen for the reception and entertainment of the visitors has been effected by the election of James Albert Green, Matthew Addy & Co., as permanent chairman; Wm. Gilbert, Buckeye Foundry Co., treasurer, and W. L. Finch, of the Convention League, secretary. The following sub-committees have been named:

Finance—Geo. Morris, John B. Morris Foundry Co., chairman; Theo. Bollmann, Bollmann-Wilson Foundry Co.; Lewis Walter, Walter-Wallingford & Co.; Walter Geier, Modern Foundry Co.; F. [illegible] Brunner, S. Obermayer & Co.

Entertainment—J. K. Pollock, Rogers, Brown & Co., chairman; J. A. Green, Matthew Addy & Co.; Harry F. Frohman, S. Obermayer Co.; F. M. Eaton, Hickman, Williams & Co.; John Sargent, Domhoff & Joyce Co.

Hall—John Hill, Hill & Griffith Co., chairman; John J. Bruce, John J. Bruce Foundry Co.; Justice Thorner, S. Obermayer Co.; F. W. Weissman, secretary of the Cincinnati Foundry Foremen's Association and Herbert Black, Hickman, Williams & Co.

Supply Association.

On Friday and Saturday, Feb. 5 and 6, a special meeting of the executive committee of the Foundry and Manufacturers' Supply Association was held at the Hotel Sinton, Cincinnati, for the purpose of making arrangements for the exhibit, which will be held in Music Hall. The following members were present: F. N. Perkins, president; Geo. H. Wadsworth, John Hill and E. J Woodison, vice presidents; J. S. McCormick, treasurer; C. E. Hoyt, secretary; Geo. R. Rayner, J. S. Smith, U. E. Kanaval and E. A. Pridmore. L. L. Anthes, president of the American Foundrymen's Association, and Dr. Richard Moldenke, secretary, met with the committee, and it was decided to charge an admission fee of 25 cents for a single attendance, and season tickets will be sold at the registration desk which will entitle visitors to attendance throughout the week at a cost of $1. The free list will be entirely suspended and season tickets will be purchased by the secretary for duly accredited members of the press and the local entertainment committee. The cost of exhibit places in Music Hall will be as follows: Ground floor with booth railings, 50 cents per square foot; second floor with booth railings, 35 cents per square foot. Temporarily building, without railings, 35 cents per square foot. An extra charge of $10 will be made for all corner booths.

Power Equipment.

The buildings have been placed at the disposal of the association by the Cincinnati committee free of charge, and light will also be furnished. Individual motors must be used by exhibitors requiring power and the building is wired for direct-current 110-220 volts. An air compressor will be installed for those requiring compressed air. All signs will be 18 inches high and will be placed uniformly in all booths. The executive committee decided to create a surplus of $1,500, but all earnings in excess of that amount will be divided pro rata among space users after the convention.

Considerable space has already been sold by the secretary, and the indications are that the number of individual exhibits will far exceed those at the Toronto convention. The size of the temporary building will be definitely decided after the number of exhibits to be provided for in that space is ascertained.

The registration booth will be located in Music Hall, where the meetings of the American Foundrymen's Association, American Brass Founders' Association, and Associated Foundry Foremen will be held. The Hotel Sinton has been selected as headquarters for the members of the American Foundrymen's Association and the American Brass Founders' Association, while the headquarters of the Associated Foundry Foremen will be established at the Grand hotel.

MOLDING MACHINE-MADE PLOWPOINTS

Novel method of mounting plowpoint patterns on a molding machine--- Difficulties with back-draft successfully overcome- -Economies effected

WHILE many efforts have been made to mold plowpoints on molding machines, the back-drafting of the land side pattern involved difficulties that were not easily overcome, and the drawing of this part of the pattern by hand more than offset other economies effected by the use of the machine. By the use of a special upper head adapted for this work, plowpoints are now being successfully molded on a multiple molding machine built by the Rathbone Molding Machine Co., Detroit, installed in the plant of the Vulcan Plow Co., Evansville, Ind. The essential features of this head are the retention of the heavy chill on the lower side of the upper head by electro-magnets, and the carrying of the land side part of the pattern on the axle so that it can be stripped out of the mold at the proper angle.

Output.

A complete mold is made at each operation, the flasks being stacked 11 high, making 10 molds, the lower cope and the upper drag being lost. The average daily output for two men, the one operating the machine and the other oiling the chills, shoveling sand and carrying away stacks, is 380 molds, or 38 stacks. When molded by hand, the average output is 56 molds for one molder, and the saving effected in the molding cost is approximately 65 per cent. To this should also be added a 40 per cent saving in grinding and fitting, as machine-made plowpoints are more uniform and require less time for fitting. With the interest on the investment, repairs, etc., taken into consideration, it is estimated that the actual saving over hand work is about 50 per cent.

Reduced Floor Space.

The reduced floor space required when the molds are stacked is another factor of importance. When made on the floor in square flasks, 32 x 20 inches, 380 molds would occupy 844 square feet of floor space as compared with 98 square feet for 38 stacks of 10 molds each. In addition, the special flasks used on the machine effect a considerable saving in sand as they conform closely to the shape of the pattern, whereas square flasks are used for hand work.

Multiple Molding Machine.

The multiple molding machine equipped with a special head is shown in Figs. 1, 2, 3 and 4. The sand frame and flask on the lower head of the machine, dropped away from the upper head are shown in Fig. 1. The land side part of the pattern is also shown lowered in the position it would assume while the mold is being rammed. The lower head is shown raised in Fig. 2, the position it assumes during the ramming operation, and the land side portion of the pattern in this view is drawn out of the mold. This is accomplished by merely depressing the handle. When in molding position it is held by a spring latch which is re-

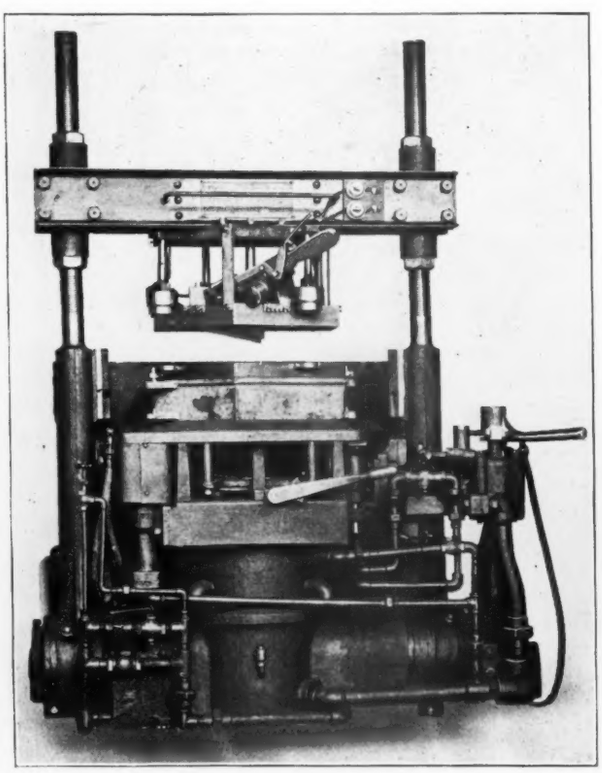


FIG. 1—LAND SIDE SECTION OF PATTERN LOWERED THROUGH UPPER HEAD

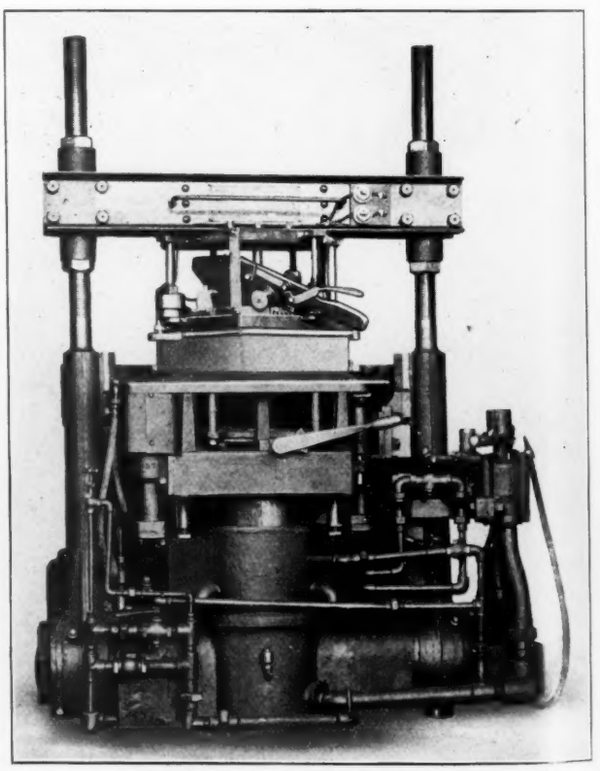


FIG. 2—MULTIPLE MOLDING MACHINE IN RAMMING POSITION

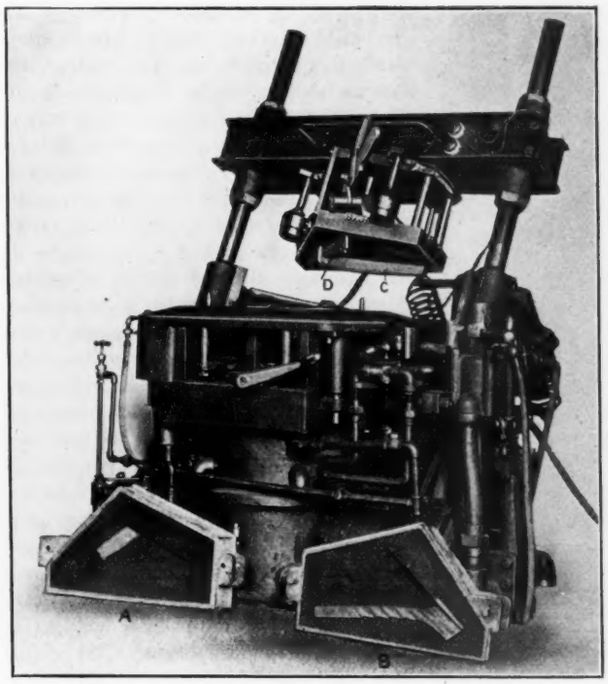


FIG. 8—COPE AND DRAG HALVES OF THE MOLD ARE SHOWN AT A AND B

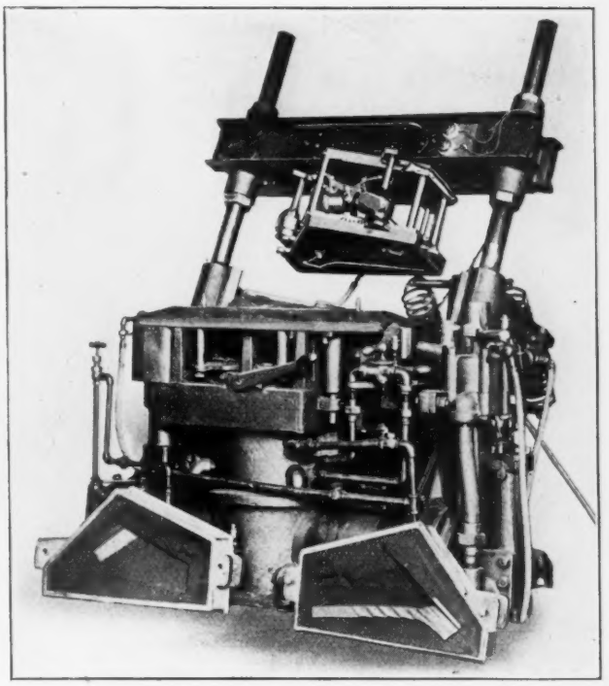


FIG. 4—LARGE CHILL IN POSITION ON UPPER HEAD

leased when the pattern is raised out of the sand. In Fig. 3 the head is swung back, the land side pattern is shown at D, and the heavy chill C, which is carried in the drag, is shown held in the bottom of the upper head by electro-magnets. The cope half of the mold is shown at A with a small chill imbedded in the sand, which is laid on the cope pattern on the lower head of the machine. This is known as the face chill and lifts off with the sand. The drag half of the mold is shown at B with the heavy chill C in the sand. In Fig. 4 the land side section of the pattern is drawn, but the heavy chill is held to the upper head by electro-magnets.

Sand Former.

The land side section of the plowpoint is back-drafted and joins the face of the latter, that is, that portion that joins the mold board at an angle of about 45 degrees. It is hinged to the upper head in such a way that it describes an arc of a circle when drawn out of the sand, this movement being similar to that performed by the molder when removing this section of the pattern from the mold with a large chill to guide him. As the mold has an extremely irregular parting and carries deep pockets of sand on either side of the land side pattern, and to assist the flow of sand into these recesses, a former has been devised and is used for roughly building up the drag mold. This device is shown in position in Fig. 6, and in Fig. 7 it has been removed and the sand has been carried several inches above the top of the flask.

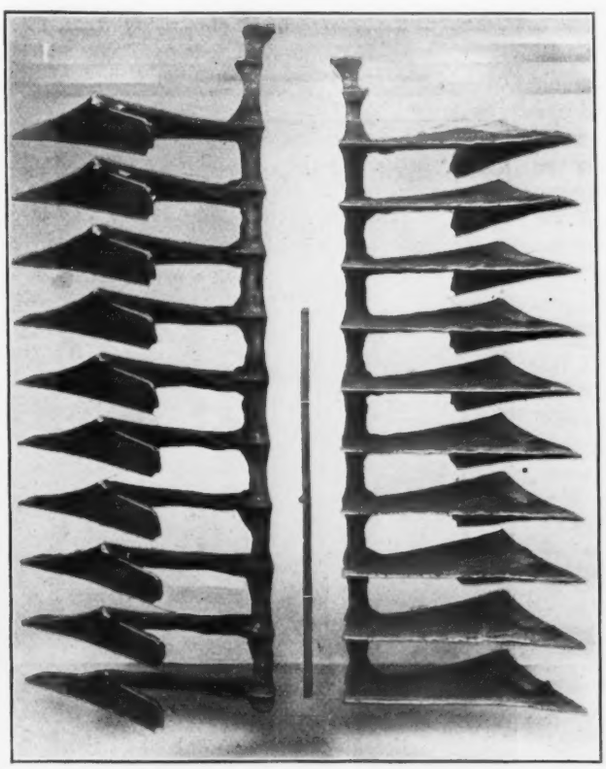


FIG. 5—TWO VIEWS OF TEN PLOWPOINT CASTINGS ON ONE SPRUE

Method of Operation.

When ramming a mold the face chill is placed on the cope pattern, the flask is set on the lower ramming head and the sand frame is lifted from the upper ramming head, where it is held by electro-magnets and is placed on the flask. The heavy chill is then set against the upper head, the flow of the current having been directed from the magnets that hold the sand frame into those provided for the chill. The sand former is next placed on the flask, which is then filled with sand. After the former has been removed, the upper head is swung over and with the land side section of the pattern projecting through the drag pattern, the mold is rammed by the upward movement of the lower ramming head. The high velocity at which the sand is projected against the drag pattern causes it to flow into the deep pockets and the back draft of the pattern.

Stripping Land Side Pattern.

The land side pattern is then stripped out of the mold by depressing the lever, the chill is released by turning the switch, which directs the flow of the current from the magnets holding the chill to those that carry the sand frame. The latter is then

FIG. 6—MOLDING MACHINE, SAND CONVEYOR AND SAND HOPPER

picked up and is held by the upper ramming head. The cope pattern is drawn by raising the flask from the lower head by air-operated pistons. The flask is then lifted off and placed on the stack, no rolling over being required. The removal of the flask automatically opens a pop valve and the superfluous sand is blown from the cope pattern, thus obviating the necessity of brushing this pattern off by hand. The cope pattern drawing device is operated by a foot pedal which elevates the flask and in the movement of the operator carrying off the flask, thereby releasing the pedal, the flask elevating device returns to position to receive another flask. Setting the flask on the lower head depresses pins operating the pop valve and cuts off the flow of air that blows the sand from the cope pattern.

Sprues.

A sprue is cut through each mold, one-half being in the cope pattern and the other half in the drag. The lower sprue is closed by a cork-shaped core to prevent the flow of the metal through the bottom of the stack. By cutting the sprue through each mold a continuous sprue is secured and to obtain a sufficient head of metal for the top mold, pouring cups are used, as shown in Fig. 8. Light clamps are placed on the stacks to prevent straining in the upper molds only. The lower molds are sufficiently weighted by the superimposed flasks.

Flasks.

The flasks are cast iron, 3⅝ inches deep, and the minimum depth of sand between the castings is ¾-inch. The minimum amount of sand between the pattern and the inside of the flask is one inch. The flasks have a length of 20 inches on one side, are 7½ and 4 inches respectively on the ends, while the opposite sides form an obtuse angle, and are 13 and 12 inches long, respectively. The shape of the flask is clearly shown in Figs. 3 and 4.

Pouring the Molds.

The method of pouring plowpoints is shown in Fig. 8. A bull ladle of 700 pounds capacity is used, which is hung from a Curtis air hoist operated on an overhead traveling crane, which commands this entire floor. The castings are likewise shaken out of the stacks by an air hoist, as shown in Fig 9. A ram is fastened to the lower flange of the air cylinder and the stack is picked up by a bell hung from a yoke on the air hoist. The upper movement of the piston raises the stack of flasks and by contact with the bottom of the ram which is similar in shape to the flasks, but is somewhat smaller in dimensions, the castings are pushed out. The time required for shaking out 380 molds by this method is 30 minutes. Two views of 10 plowpoint castings on one sprue with a two-foot rule between them are shown in Fig. 5. The front and reverse sides of one of the plowpoints molded on this machine are shown in Fig, 9. They are 10 inches long and weigh about 7 pounds each, and plowpoints 11 and 12 inches long can also be made on this machine without a change of the upper heads. The chills are coated with crude oil which is cut with kerosene when too thick. While the average losses are very low, the phenomenal record of one defective casting out of a lot of 380 was recently made.

Sand Handling Equipment.

All of the sand is handled by a conveyor and is dumped into a hopper at the bottom of which is a box which holds the proper amount of sand to fill one flask. The sand is riddled into a hopper below the floor level through a shaking riddle, into which it is shoveled by the operator's helper. It flows from the hopper into the boot of the conveyor and is carried by buckets and dropped into a hopper

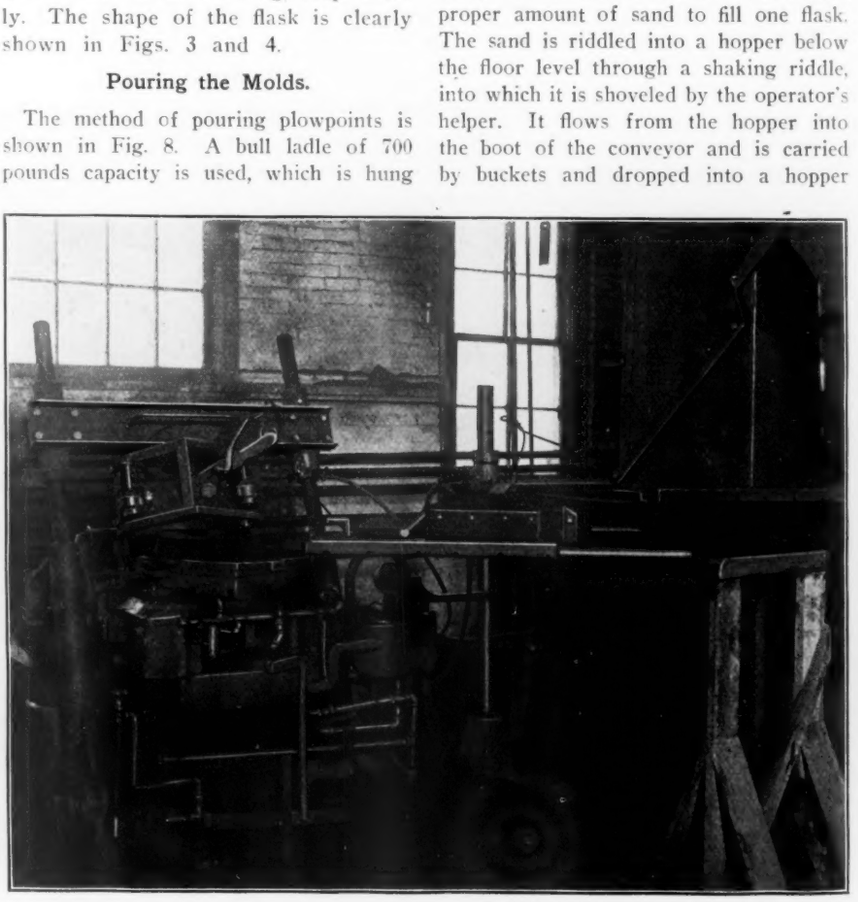


FIG. 7—SAND BOX WITHDRAWN FROM UNDERNEATH THE SAND HOPPER

close to the molding machine, as shown in Fig. 6. From this hopper, the sand flows into a box and when this is drawn forward, as shown in Fig. 7, it cuts off the further flow of sand from the hopper by drawing forward a steel plate. As the sand box is swung over the flask on the machine it passes over an opening in a steel plate, which at one end forms a bottom for the box, and the sand flows into the flask. When the sand box is again swung back it passes over the opening in the steel plate to that portion which forms its bottom when it is underneath the hopper. When swinging into position underneath the hopper, it forces back the steel plate that was swung forward to stop the flow of sand and the box is again filled. The sand box is attached to a bar which swings on a steel shaft, but when underneath the hopper it is held up at one end by wood supports as shown. The constant riddling of the sand improves its quality to a marked degree.

Cupola Practice.

The melting practice at the plant of the Vulcan Plow Co. is unique, inasmuch as four separate mixtures of iron are charged into the cupola during one heat. For making plowpoints, land sides and mold boards, a high chilling mixture must be used, but the greatest amount of chill is required for the mold boards. High manganese and charcoal irons are used and the first iron tapped is for the mold board castings. The mixture for the land sides is charged next as these castings are not quite as hard as the mold boards. The third mixture is used for plow points which are only chilled on the cutting edge and on a part of the face, and require a soft iron next to the chilled sections. The soft gray iron mixture is charged last.

Annealing.

Inasmuch as the mold boards are chilled over their entire surface, and owing to their thin section, they are converted practically into a white iron, and are consequently annealed to overcome internal strains. The annealing practice is similar to that pursued in car wheel foundries. Immediately after the mold boards have been shaken out they are placed in a brick lined pit and are covered with sand. They are permitted to remain in the pit for 36 to 48 hours until nearly cold. Unannealed, these castings are too brittle to handle.

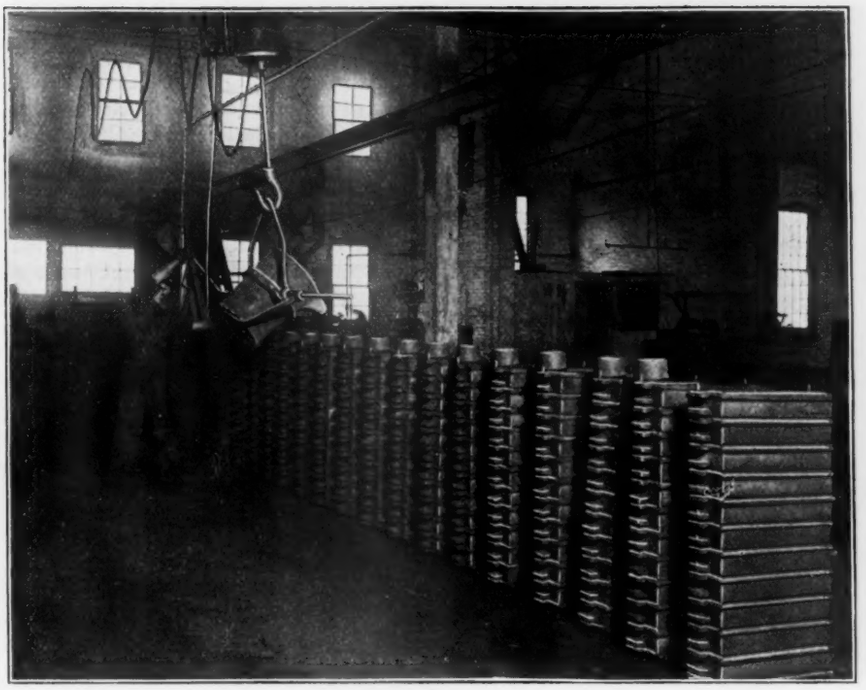


FIG 8—METHOD OF POURING THE STACKED MOLDS

FIG. 9—FRONT AND INSIDE VIEWS OF THE PLOWPOINT CASTINGS

BRASS MELTING DIFFICULTIES.

Question:—We have been making plain condenser tube plates, but these have invariably been unable to withstand the hydrostatic test to which they were subjected. We have cast them both in green and dry sand molds and use gun metal—copper 88, tin 10 and zinc 2. The molds are given a coat of blacking and are thoroughly dried with a wood fire and are cast before they have had time to cool. These castings are 1⅛ inches thick, 5 feet 3½ inches long and 23 inches wide. They contain one core 3 inches wide and 17 inches long. The flasks are raised 8 inches on one side. Three pouring gates are used, as well as two feeders, 3 inches in diameter, and all are built up 6 inches higher than the top of the cope. When the castings are taken out of the sand they seem smooth and clean, but when subjected to a pressure of 15 pounds per square inch, they prove defective, and when machined have a spongy appearance.

Answer:—It is fashionable among brass founders to blame the molders in a case like this, and I believe that is what has occurred in this instance. A little reflection, however, even to the most biased mind, should convince one that the molders have done their work well. Here we have castings which came out of the sand smooth and clean and look solid. Therefore, the sand did not scab, the mold or core did not blow, otherwise the casting would not have been smooth and clean. In short, the casting was good and the men who had constructed the mold did their work skillfully and well; nevertheless, some one blundered.

The weakest point in brass foundry

practice today lies in the melting of the metal. The writer has experienced as many difficulties along these lines as most foundrymen, and it took him many years to solve some of the problems that presented themselves from day to day. Many ludicrous expedients were resorted to in the way of gating and molding simple jobs, so that the man at the lathe would not think he was turning a beehive and had just struck the comb when he took off the first cut. The discharge of the melter, however, would have been the simplest way out of the dilemma. It is always advisable to employ a man skilled in melting and even if it costs more, it pays. This is what I have always done, and when a man could not be found, I have looked after the melting myself until another was secured. This can be recommended as a specific for this disease in all cases where the old and experienced (?) melter cannot be brought to see the error of his ways.

Charcoal is cheaper than spongy castings and is a great preventive. Therefore, in melting copper or its alloys, use charcoal on the metal as a cover, always. If charcoal cannot be obtained, use hardwood blocks or tan bark, or any organic substance which burns to charcoal. Common salt is also advised where there has been trouble, a handful being placed in the bottom of the crucible when beginning to melt. Glass also makes an excellent cover, and in charging new metal into some already melted, it is advisable to bridge the top of the crucible with a few gates or suitable pieces of scrap, piling the cold metal on top. When it has become heated, push it into the melted portion, getting it under the cover of charcoal, etc., as soon as possible.

Why are these precautions necessary? It is because copper and its alloys when heated are attacked by the oxygen in the air. In short, they burn the same as wood, paper, or any other combustible substance, and the product of this burning is ashes and gas, and in the case of metals, the ashes are called oxides or rust. Copper dissolves its own oxides, consequently if the metal is not protected from the oxygen when being melted, the result is a mixture of metal and ashes, and the entire contents of the crucible could be burned to ashes if the operation were carried far enough. In the case of the alloy given we obtain a metal composed of copper, oxygen, tin and zinc. With a small percentage of oxygen, the castings will appear solid when machined, but their strength is reduced, as ashes are weak in cohesive force. This is one reason why phosphorus, magnesium, manganese, etc., strengthen bronzes. They combine with and remove the oxygen, which floats to the top of the melted alloy as a slag.

The limit to the amount of oxygen which can be carried by a copper alloy and cast solid has not been defined, but it undoubtedly exists. When this limit is exceeded it seems probable that the metal in solidifying endeavors to rid itself of the gas which is squeezed from the center of the casting upward at enormous pressure. In its passage through the metal the gas encounters and is trapped by the solidified envelope of metal in contact with the walls of the mold. Even a mold heated to 130 degrees Fahr. will chill and set the metal immediately in contact with it. The casting, therefore, appears solid, as this outer casing of metal when setting squeezes its excess of oxygen inwardly, that being the line of least resistance. Therefore, when this skin is peeled off the casting by tools, we find bubble holes or cavities which have been compared with sponges and honeycombs. My advice in this case is to change the melting arrangements, and possibly change the mixture, a better one being copper 90 pounds, tin eight pounds, and phosphor tin, two pounds.

K. K.

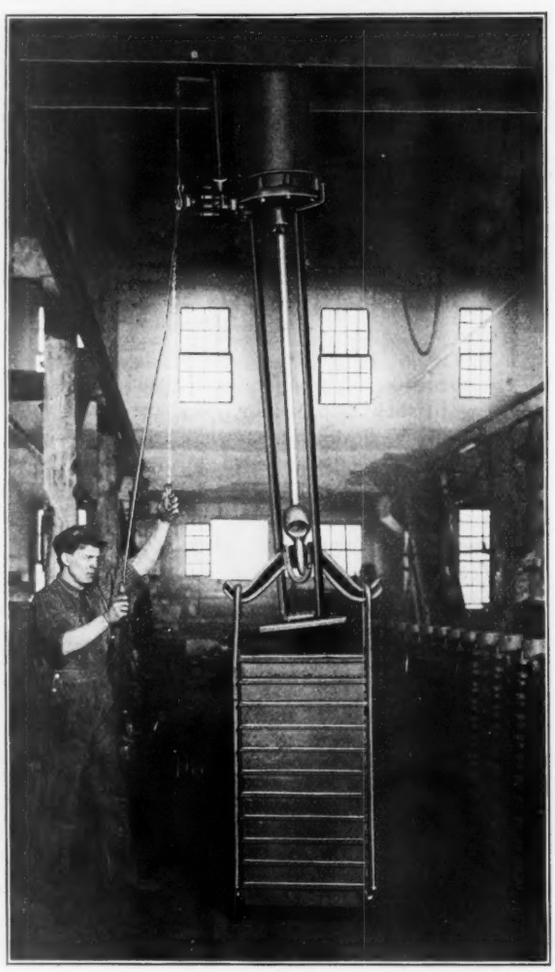


FIG. 10—METHOD OF SHAKING OUT THE STACKED MOLDS

CAST IRON POTS FOR MELTING LEAD.

BY W. J. KEEP

Question:—We have been making cast iron pots for melting lead for some time, and as long as the concern to whom they were shipped used coke as fuel they gave satisfaction. However, since oil has been used, the pots burned out rapidly and developed pin holes and cracks. We have tried several mixtures as follows: Steel scrap, 300 pounds, and machinery scrap, 1,000 pounds; steel scrap, 100 pounds, machinery scrap, 1,800 pounds, and No. 3 foundry iron, 100 pounds. The third mixture was the same as the first, except that horseshoes were substituted for steel scrap. We have been using the first mixture with varying results, and have added five pounds of ferro-manganese to each ladle of 1,800 pounds of iron. We are now melting twice the amount of iron that we require and are casting the surplus into pigs to be used for the next lot of pots. We have found that we get a cleaner metal with a closer grain by doing this. Our mixture contains from 2.75 to 3 per cent of silicon. Can you suggest a better mixture?

Answer:-The first mixture would hardly contain more than 2 per cent silicon, and the sulphur would naturally be about 0.10 per cent. Casting into pigs and remelting only increases the sulphur content. It would seem advisable to melt the scrap only once. The oil undoubtedly contains a higher percentage of sulphur than the gases arising from the coke fire. The pots are kept at a high temperature and probably there is more free oxygen in the oil fire than in the gases from the coke fire, and in that case the iron is burnt. If the concern using these pots will endeavor to secure a better mixture of air with its oil, and less free air in the chamber around the pots, the latter will probably last longer.

JARRING AND HINGED MOLDING MACHINE

A large combination machine designed for molding car wheel centers which rams the mold, rolls over the flask and draws the pattern

A LARGE combined jarring and hinged molding machine, designed to produce from 50 to 75 molds of car wheel centers per day of ten hours, operated by three men who formerly made eight molds by hand, has been installed by the Standard Steel Co., Burnham, Pa. The machine, built especially for molding car wheel centers can also be used on a great variety of work which does not exceed in weight the capacity of the roll-over cylinder, which would be a net weight of 2500 pounds including flask, pattern, bottom board and sand. The complete machine weighs 30,000 pounds and is set in a pit with the pattern plate level with the floor occupying a space, 7 x 12½ feet. It has a capacity for flasks from 36 to 44 inches, inside diameter.

This machine marks a distinct advance in the art of machine molding. By combining the Tabor jarring and hinged machines the production on certain classes of work can be multiplied many times. The jarring machine saves nearly all of the ramming time and the hinged machine saves time in pattern drawing and finishing, so that the combination of the two leaves very little for the molder to do besides shoveling sand and carrying away finished molds. To facilitate the rapid operation of machines of this type, sand should be brought to the machine by a conveyor or a clam-shell bucket on a traveling crane, and the molds removed by a hoist or crane.

Construction.

The machine consists of an anvil, in the center of which a 13 inch jarring machine with a 42 x 48 inch table, is placed. At one end of the anvil a 20 inch roll-over cylinder is mounted which carries a hinged frame, the arms of which are made to come down clear of the jarring table on either side of its shorter dimension. The arms carry the pattern plate which is centered on the table by dowel pins, and when the pattern plate has been lowered upon the jarring table, the arms of the hinged frame drop away from it, so there is no connection whatever between the jarring table and roll-over mechanism during the process of jar-ramming.

After the mold has been jar-rammed to the proper density and the bottom board clamped on the flask, pressure is admitted to the roll-over cylinder which brings the arms of the hinged frame up in contact with the pattern plate. During this movement the dowel pins in the hinged frame enter bushed holes in the pattern plate, thus doweling the pattern plate to the hinged frame before lifting the pattern plate off the dowel pins in the table of the jarring machine. This movement lifts the pattern plate with the flask off the dowel pins and clear of the table, continuing until the end of the vertical movement is reached and the roll-over movement begins. From this point the pattern plate is securely locked automatically, to the hinged frame, so that when rolled over, it remains suspended with the flask and bottom board clamped to it.

The hinged frame having passed the balancing point, the pressure is released from the roll-over cylinder and the mold is lowered upon the equalizing table, as

FIG. 1—PATTERN DRAWN AND HINGED FRAME SWUNG BACK

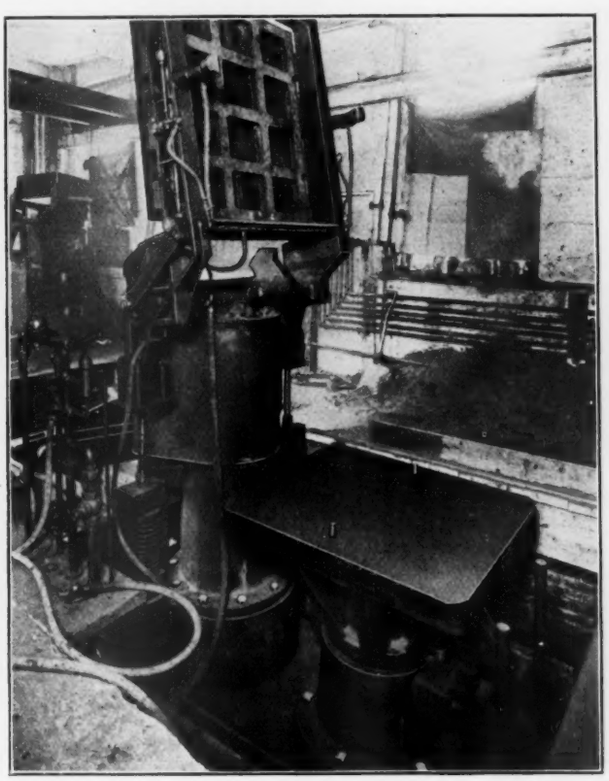


FIG. 2—JARRING END OF THE COMBINED JARRING AND HINGED MOLDING MACHINE

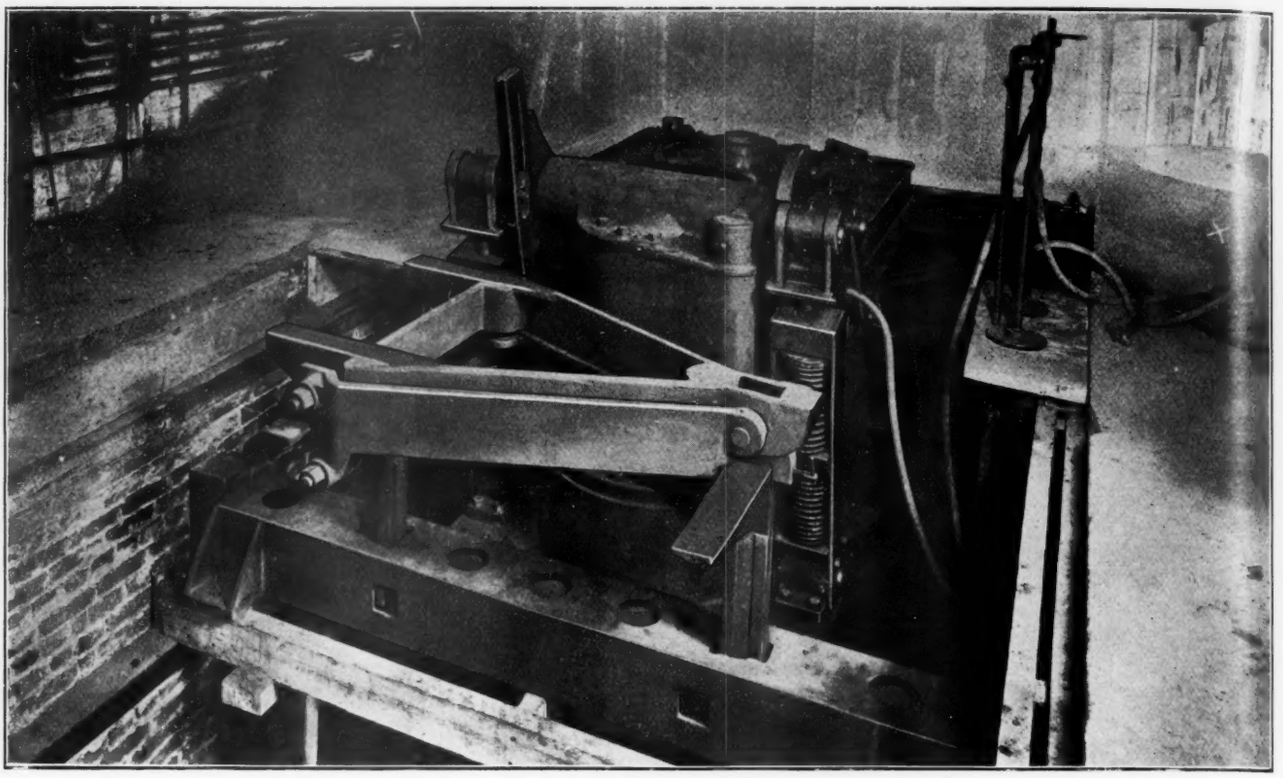


FIG. 3—PATTERN BOARD ON JARRING TABLE READY TO RECEIVE FLASK

shown in Fig. 4. In machines of this type the unbalanced weight of the piston, piston head and that portion of the hinged frame which contained the flask, is automatically balanced by compression springs contained in the links attached to the levers of the hinged frame, which assist in producing the roll-over movement and are located at each side of the roll-over cylinder. These counterbalance springs act shortly before the bottom board, which is clamped to the flask, reaches the equalizing table and take up all lost motion in the hinged frame and its actuating members, rendering them in a perfect state of balance, so that after the combined weight rests on the equalizing table, thereby setting the table positively, there will be no movement of the mold or pattern plate when the clamps are released.

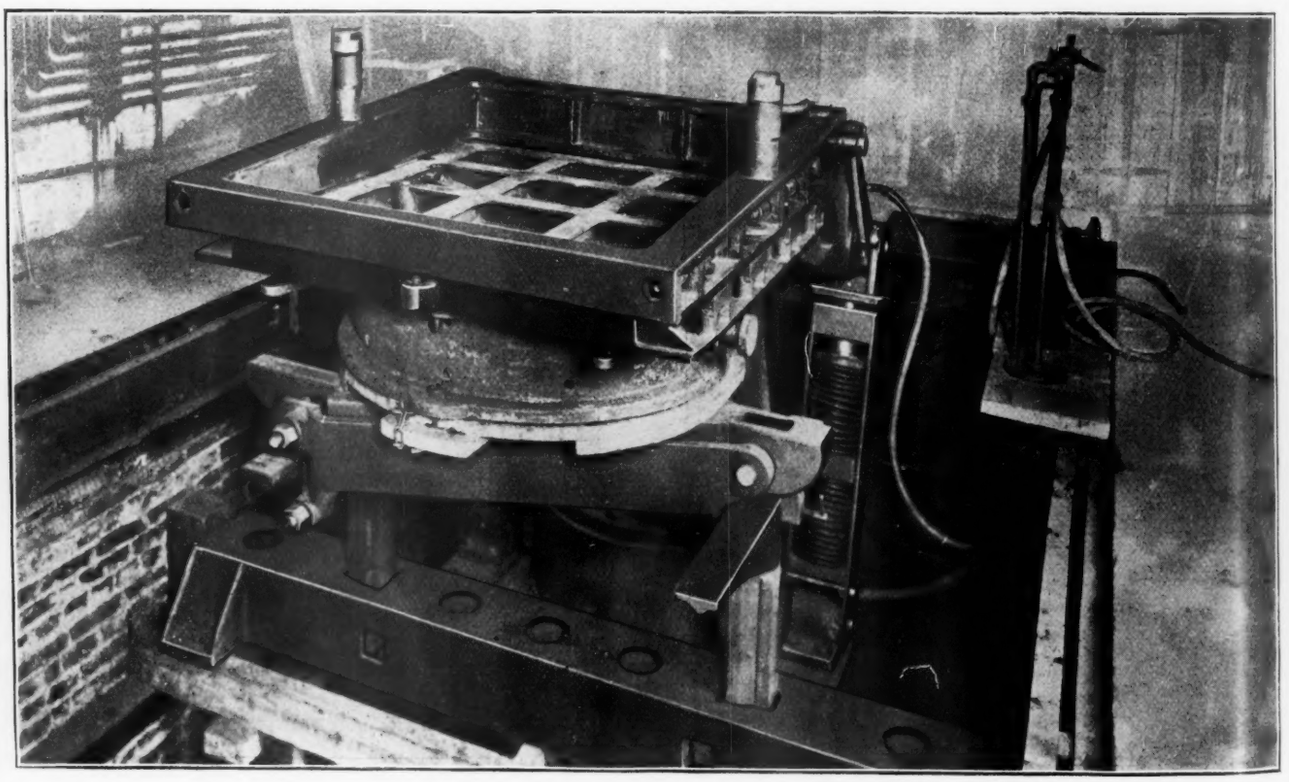


FIG. 4—FLASK ROLLED OVER WITH BOTTOM BOARD RESTING ON THE EQUALIZING TABLE

These machines are provided with a speed regulator which automatically increases the speed of the roll-over cylinder from the beginning to the end of the roll-over movement in both directions. This assures a rapid transfer of the mold from the jarring table to the equalizing table. The speed of the roll-over cylinder on the downward movement, in either direction, is choked gradually so as to be absolutely free from shock.

To secure the requisite strength and freedom from undue wear, and to assure a straight pattern draft, a large diameter cylinder, having an extra long bearing and operated in oil, has been provided, as well as ample means for taking up lost motion due to wear of the operating parts.

matically adjusts itself to receive another flask. It is also provided with a vertical adjustment so as to care for the varying depths of flasks.

The device employed to lock the pattern plate to the hinged frame is provided with an automatic safety attachment to prevent the mold from being rolled over unless the pattern plate is securely locked to the hinged frame. During the return of the hinged frame to its position on the jarring machine, it is automatically unlocked from the pattern plate, so that when the latter settles on the dowel pins in the jarring table, the former is free to drop clear of the pattern plate to its proper position.

conveniently located so as not to interfere with operating the machine. Formerly the jarring machine proper was made automatic in its action. This neccessitated the valve being actuated by the table, and as the valve must be opened before the table reached the end of its stroke, an air cushion resulted. To eliminate any possibility of an air cushion the valve is provided with a large exhaust port which remains at full opening during the full length of the downward stroke of the jarring table and until the next operation of the pilot valve. For convenience in counting the blows and to avoid the possibility of striking more blows than are desired, the main valve

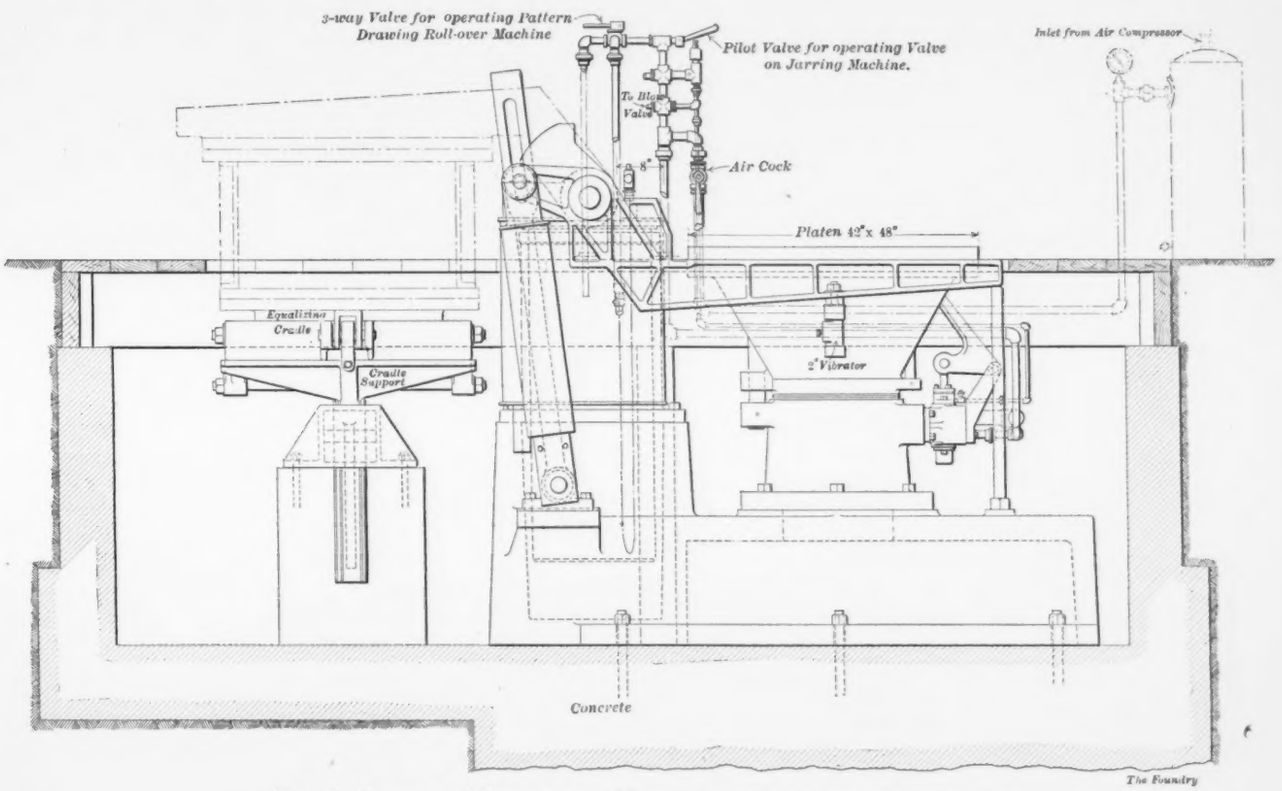


FIG. 5—SECTIONAL VIEW OF THE MACHINE IN BRICK AND CONCRETE PIT

Levelling Device.

The equalizing table is an automatic levelling device, by which the mold is set without reference to the pattern plate no matter how crooked the bottom board may be, and absolute stability is secured by supporting the bottom board on three points only. As soon as the weight of the mold comes upon the levelling cradle, it locks and holds it in a set position, while the pattern is drawn, as shown in Fig. 1. Here the pattern plate has been lifted out of the mold and is in the act of turning back to its position on the jarring machine as shown in Fig. 3.

When the weight of the mold is removed from the equalizing cradle it auto-

Eighteen inches of pattern draft has been provided, making the machine available for deep work of any kind suitable for jar-ramming. With this type of machine it is possible to draw a pattern having the least possible amount of draft, in fact, with the use of a vibrator it is possible to draw patterns of considerable depth without draft.

In conjunction with the operation of this machine there has been provided an arrangement for quickly locating the pattern in relation to the flask pins, assuring a perfect match when the two halves of the mold are closed. This arrangement facilitates a rapid changing from the pattern of one distinctive type to another.

All operations of the machine are controlled by three valves forming a stand

is operated in one direction by a pilot valve, and in the other direction automatically by the machine itself, for the purpose of limiting the strokes, which is made adjustable. The number of blows struck per minute is not so great as formerly but the ramming effect in a given time, is greater, because the cushioning effect of the automatic valve has been entirely avoided.

Method of Operation.

When making a mold the flask is set on the table in its proper position and clamped to the pattern plate. The sand frame is then placed on the flask which is filled with sand. The sand frame is a temporary extension of the flask which carries the excess loose sand necessary to fill the flask as it becomes compact by

(Continued on page 43.)

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Pouring Machine Made Molds

The problem of pouring off floors of machine made molds is growing increasingly difficult of solution, especially in small foundries where the tonnage is not sufficiently heavy to warrant the continuous operation of the cupola, or the installation of pouring bridges, conveyors, etc., for disposing of the molds as rapidly as they are made. The output of modern molding machines has increased so rapidly in recent years that it has become almost a physical impossibility for the machine operators to pour their floors during the brief duration of the heat. In one large stove shop, one operator pours off approximately 240 molds and as the sections are heavy, from 75 to 80 hand ladles of iron are required. While the metal is conveyed to his floor, nevertheless the work of pouring off is arduous to say the least. This is, however, an exceptional case, inasmuch as few floors of machine—made molds require more than 40 or 45 ladles of iron. In many shops the average per floor of light work is about 25 ladles.

Decline in Pig Iron Production

Statistics compiled by the American Iron and Steel Association show a big decline in pig iron production in 1908 as compared with the previous year. The total output of all kinds of pig iron in the United States last year was 15,936,018 gross tons, against 25,781,361 tons in 1907, a decrease of 9,845,343 tons, or over 38.1 per cent. The half yearly production in the last three years in gross tons is given below:

Periods.	1906.	1907.	1908.
First half	12,582,250	13,478,044	6,918,004
Second half	12,724,941	12,303,317	9,018,014
Total, Tons	25,307,191	25,781,361	15,936,018

The following table gives the production of pig iron in the United States from 1900 to 1908 in gross tons. There was an increase in the second half of 1908 over the first half of 2,100,010 tons, or 30.3 per cent.

Years.	Total, Tons.	Increase or Decrease, Tons.
1900	13,789,242	Dec. 1,495,896
1901	15,878,354	Inc. 529,128
1902	17,821,307	Inc 204,159
1903	18,009,252	Dec. 1,405,482
1904	16,497,033	Inc. 150,157
1905	22,992,380	Inc. 666,030
1906	25,307,191	Inc. 142,691
1907	25,781,361	Dec. 1,174,727
1908	15,936,018	Inc. 2,100,010

The production of Bessemer and low-phosphorus pig iron in 1908 was 7,216,976 tons, against 13,231,620 tons in 1907, a decrease of 6,014,644 tons, or over 45.4 per cent. In the second half of 1908 the production was 3,828,485 tons, as compared with 3,388,491 tons in the first half, an increase of 439,994 tons. The production of low-phosphorus pig iron alone in 1908 amounted to 130,616 tons, against 204,537 tons in 1907. The production of Bessemer and low-phosphorus pig iron in 1908 was the smallest since 1897, when 5,795,584 tons were made. The production of basic pig iron in 1908, not including charcoal of basic quality, was 4,010,144 tons, against 5,375,219 tons in 1907, a decrease of 1,365,075 tons, or nearly 25.4 per cent. In the second half of 1908 the production amounted to 2,528,532 tons, against 1,481,612 tons in the first half, an increase of 1,046,920 tons. The total production in 1908 was slightly less than that of 1905, when 4,105,179 tons were made. The production of spiegeleisen and ferro-manganese in 1908 was 152,018 tons, against 339,348 tons in 1907, a decrease of 187,330 tons. The production of ferro-manganese alone in 1908 was 40,642 tons, against 55,918 tons in 1907. Of spiegeleisen alone it was 111,376 tons, against 283,430 tons in 1907. The total output of steel ingots and castings in 1908 was 6,116,755 gross tons, against 11,667,549 tons in 1907, a decrease of 5,550,794 tons, or over 47.5 per cent.

Trade Outlook

The open market recently established on steel products and the abrogation of all price agreements, if such they might be termed, on all commodities except rails, foreshadows lower values than have existed during the last 18 months, and will undoubtedly be the forerunner of reduced prices on pig iron. Concessions from ruling quotations have been made for sometime by independent interests and the entire market has been in an extremely unsettled condition. The result of this action can only be conjectured at this time, but it is certain that any tonnage held in abeyance on account of existing prices, will certainly be placed when the lower level is reached. Heretofore, an open market has usually led to prices which represented the cost of production and many sales were made that incurred heavy losses. A speedy recovery is, however, anticipated, and if a large tonnage is placed at low values it will certainly hasten the return of prosperity. In the foundry trade the melt has shown a slight increase, mostly in gray iron shops. Stove plants with few exceptions are idle and their period of activity this year will be limited on account of the large stocks carried over from last fall, due to the unseasonable weather conditions. The railroads are not contributing a heavy tonnage to the malleable and steel foundries, nor is any great improvement anticipated until the summer months. Pig iron is quoted at slightly lower prices in the leading centers as follows: Northern No. 2, Chicago, $16.50; No. 2 standard, Philadelphia, $17; No. 2 southern, Birmingham, $12.50 to $13.00; Lake Superior charcoal, Chicago, $19.50; No. 2 Cleveland $16.50; malleable Bessemer, Pittsburg, $16.50.

PRIZE CONTEST AWARDS.

Only one of the four prizes offered by THE FOUNDRY for meritorious articles on various phases of foundry practice has been awarded by the judges who passed upon the manuscript submitted. In many cases articles of merit could not be considered for the reason that the matter was not confined to one of the four subjects for which prizes were offered. The prize of $25 for the best article on "Steam Engine Cylinder Castings," was awarded to Paul R. Ramp, West Burlington, Ia.

PERSONAL.

Herman J. Trenkamp, Cleveland, has resigned as secretary of the American Stove Co., and has been succeeded by Louis Stockstrom, of St. Louis. The office of the secretary will hereafter be located in St. Louis instead of Cleveland.

James Dwyer, general manager of the Peninsular Stove Co., Detroit, together with his son and daughter, will sail for Europe on the Baltic, April 24. They will be accompanied by T. P. Kelly and wife, of New York City.

Albert H. Porsch has been appointed superintendent of the Washington Foundry & Machine Works, St. Paul, operated by Henry Orme's Sons. Mr. Porsch was formerly connected with the Iowa Foundry & Mfg. Co., Ft. Dodge, Ia.

Bradley Stoughton has announced the opening of an office at 165 Broadway, New York City, with branches in Philadelphia and Pittsburg. At present he is on a cruise to Bermuda.

G. L. Norris, engineer of tests for the Standard Steel Works, Burnham, Pa., has resigned to accept the position of engineer of tests with the American Vanadium Co., Pittsburg.

W. A. Lally, formerly general sales agent for the Scottdale Foundry & Machine Co., Scottdale, Pa., has resigned to accept a position with the Kilbourne & Jacobs Co., Columbus, O., manufacturers of cars and industrial railroads.

Among veteran molders, Joseph Knapp, employed by the Buffalo Co-Operative Stove Co., Buffalo, N. Y., who has handled the rammer for 55 years, takes first rank. Mr. Knapp was born in Buffalo, on July 18, 1839, and when 14 years of age he became an employe of Jewett & Root, then one of the largest stove foundries in the country. He remained with this concern until 1884, when he secured employment in the shop with which he is still connected.

BOOK REVIEWS.

Foundry Practice. By James M. Tate and Melvin O. Stone, M. E. John Wiley & Sons, New York. 234 pages and 112 illustrations. Cloth $2.00.

This work was prepared for the use of students in the College of Engineering, University of Minnesota, and treats of the problems of molding and casting in a somewhat elementary way. In presenting this work on foundry practice the authors realize that it is not a complete treatise on the same, but have aimed to produce a book in which the principles of foundry work are set forth concisely and clearly. The interests of the engineering students rather than those of the practical foundryman were kept in view. To this end numerous examples are given representative of the different kinds of molding, and the simple methods used in illustrating and describing the various operations involved will, undoubtedly, give the student a ready knowledge of molding, which will go far to supplement the practical work of the foundry which in a college course must necessarily be limited. Although the treatment is somewhat brief the subject matter presented is intended to cover the ordinary work in foundry practice, including both brass and iron casting. A glossary of foundry terms is also contained in this work.

Alloys (Non-Ferrous). By A. Humboldt Sexton. Manchester, England. Scientific Publishing Co., 5¾ x 8¾ inches. 283 pages. Illustrated. Cloth, $2.00, postage and duty extra.

In his introduction the author points out the four lines along which research work has been conducted in the systematic study of alloys as chemical analysis, microscopic examination, fusion and solidification, and the examination of the physical properties. The second chapter defines alloys and shows the relation of the finished products through their properties to the various constituents of which the alloys are composed.

The third chapter deals with the phenomenon of solidification, the difficulties encountered in the manufacture of alloys of uniform composition and structure and shows the advantage of slow cooling and of keeping the upper portion of the metal liquid to the last, over other methods devised for the prevention of the blow-holes, or unsoundness in alloys.

Chapters IV and V give the method of preparation of microscopic slides, and the value of microscopic study in the detection of the physical structure and the various changes that arise through cooling and annealing.

The author next deals with the properties of metals used in the manufacture of alloys; the composition and uses of the brasses whose essential constituents are copper and zinc; the bronzes which comprise the copper and tin series; the tin and lead series known as the white alloys; the various forms of babbitt; the aluminum alloys of practical value where lightness, strength and non-corrosiveness are essential; and the alloys of the rare and precious metals.

The fifteenth chapter is especially valuable as it deals with the different methods utilized in the manufacture of alloys. Here the author quotes freely from other authorities.

It may be regretted by some readers of the book that the iron series, which is the most important of all, is purposely omitted from the text, but this is pardonable because an entire volume would be required to do them justice.

JARRING AND HINGED MOLDING MACHINE.

(*Continued from page* 41.)

jarring. By means of a pilot valve a blow is struck for every depression of a hand lever and the number of blows can thus be accurately counted as found by experience is necessary for the quality of sand.

After the operation of jarring has been completed the sand frame is removed, the excess sand struck off and the bottom board clamped to the flask. Pressure is admitted to the roll-over cylinder by means of a three-way, air valve, which brings the arms of the hinged frame up in contact with the pattern plate.

After the hinged frame has passed the balancing point the pressure is released by the operator from the roll-over cylinder, allowing the hinged frame to descend to an inverted horizontal position, lowering itself in a straight line until the bottom board and suspended weight rest upon the equalizing table. The clamps are released from the flask, the vibrator started and at the same time air is slowly admitted to the roll-over cylinder until the pattern is drawn clear of the mold, when the valve is opened wide and the hinged frame rolls back to its original position. After "blowing off" the pattern plate and pattern with a blow valve provided for the purpose, the machine is ready to receive another flask.

The machine is built by the Tabor Mfg. Co., Philadelphia.

FOUNDRY & PATTERN SHOP EQUIPMENT

The Improved Gravity Molding Machine---Chipping Hammer---Electric Hoist---Oil Burner for Lighting Cupolas---Sand Blast---Stripping Plate---Sash Weight Molding Machine---Crucible Furnace---Rolled Steel Flask---Motor-Driven Band Saw

WHILE retaining the gravity ramming principle in every detail, the gravity molding machine described in the February, 1907, issue of THE FOUNDRY has been practically redesigned and reconstructed, and all parts have been standardized.

The sand for ramming molds on this machine is carried in buckets which descend into a hopper below the floor where they are loaded and the sand is then elevated, being compressed in the buckets by an automatic rammer during its ascent and is dropped from the top of the elevator to the flask carried on a swinging cradle, which can be rocked back and forth to secure an even distribution of the sand as it falls from the buckets.

The cradle can also be raised and lowered to discharge the mold and draw the pattern. Below the floor, directly underneath the cradle, is a hopper covered with a shaking riddle into which sand is shoveled and discharged into the hopper where it is fed to the buckets by a feed roll. As each bucket passes the floor level it comes in contact with the automatic packer which compresses the sand, so that it will not disintegrate in falling, but will descend in a solid mass of sufficient body to pack firmly around the pattern and to also ram the underlying layers of sand in the flask. These bodies of sand are thrown from the elevator buckets as they turn over the head sprockets.

When the flask has been filled the superfluous sand is removed with a strike-off, and after the bottom board has been adjusted the flask is clamped to the cradle, turned over, the cradle lowered and the mold is deposited on a leveling device underneath the cradle After the flask has been unclamped the cradle is drawn vertically upwards, thus drawing the pattern from the mold. The cradle is then lowerel to its operating position, the pattern board rolled over, another flask is adjusted and the operation is repeated.

The improved machine is of steel construction throughout, the base

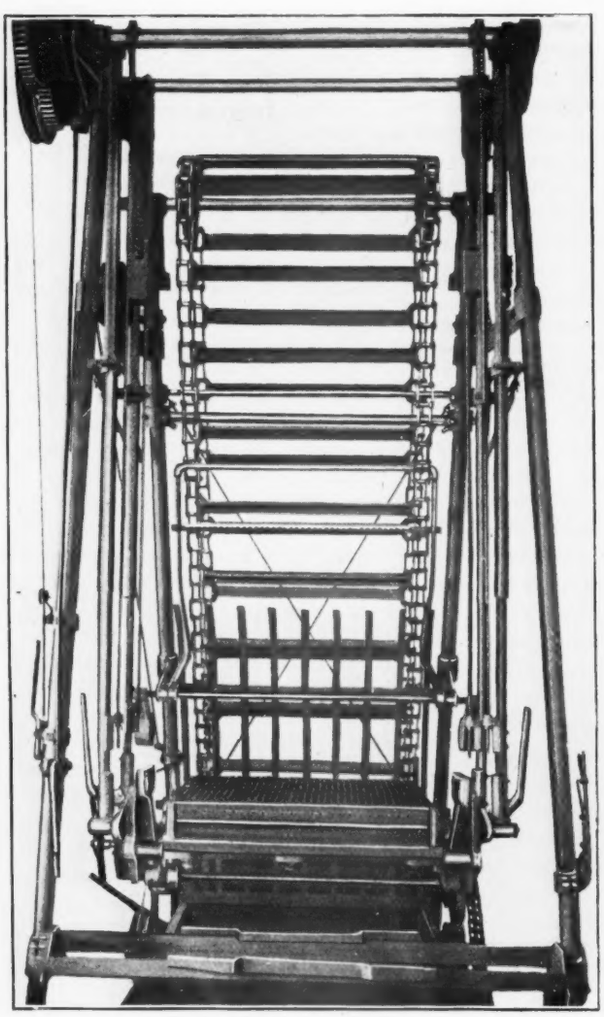


FIG. 1—FINISHED MOLD, SUPERFLUOUS SAND HAS JUST BEEN STRUCK OFF

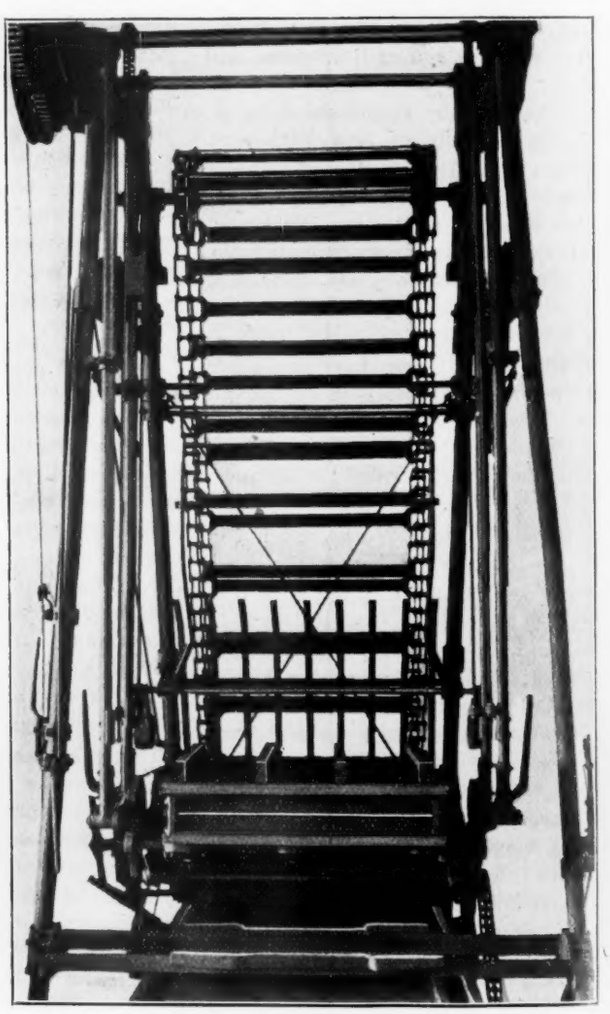


FIG. 2—BOTTOM BOARD CLAMPED ON FLASK

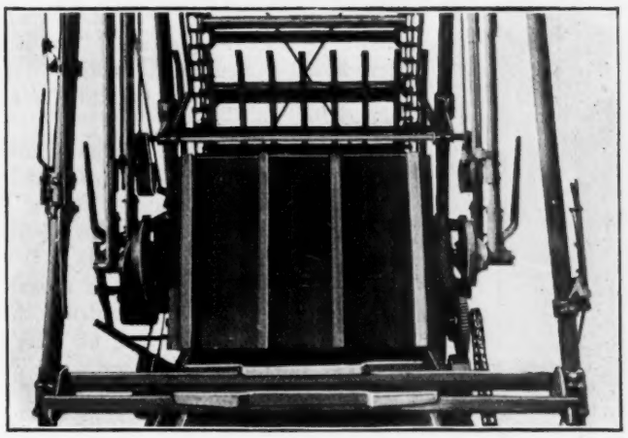


FIG. 3—POSITION THE MOLD ASSUMES WHILE IT IS BEING ROLLED OVER

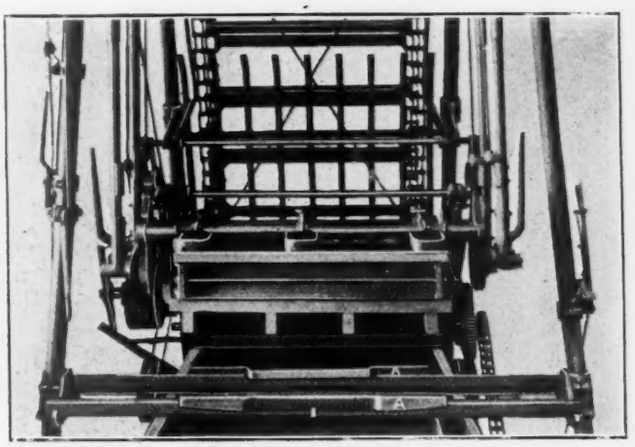


FIG. 4—MOLD ROLLED OVER BEFORE IT IS LOWERED ONTO THE LEVELLING DEVICE

being built of structural shapes and the hopper is made of steel in place of wood. Owing to the rapid wear of wire riddles from contact with the rubbing device, which thoroughly coats the sand with loam and breaks up all clods, a cast iron sieve, ⅜-inch mesh, made in halves, has been substituted. Either section of the riddle can be easily removed and replaced by one cast in the foundry. The riddle is now operated by a crank movement in place of an eccentric, the crank being a steel, drop forging. The riddle is supported by four flat spring steel bars, and is connected to the crank shaft by a ball joint. Adjustment can be made to take up wear.

The hopper is of sheet steel construction and is coated on the inside with a special preparation to prevent the sand from adhering, and thus insures a steady flow in the hopper to the boot of the conveyor. Owing to the variations in the density of the sand, the amount to be loaded into each bucket can be controlled by an adjusting device graduated to ⅛-inch. While the number of buckets has been increased, their size has been decreased, and the speed of ramming increased. The strike-off is so constructed that a flat or ridged surface of sand on the bottom of the mold can be had as desired. The cradle is counterbalanced by weights underneath the floor level, and by adding more weights, flasks heavier than those ordinarily used are counterbalanced. The vertical, upward and downward, as well as the swinging movements of the cradle are controlled by counterbalancing weights. The pattern board is level in all positions, being hung from four standards instead of two. To provide for the vertical upward and downward movement of the cradle, telescoping standards are used, and the cradle can be leveled at four points.

Automobile chains and sprockets are used for raising and lowering the cradle instead of link chains, thus insuring an absolutely steady draw of the pattern from the mold. For clamping the flask the center part of the bottom board is extended 3 inches at either end. Yoke clamps fit over these extensions and are adjusted by a lever. The clamps are adjustable to any depth of flask.

The sand packing device has also been simplified and improved, and by increasing the weight of the packer the hardness of the sand bodies in the buckets is correspondingly increased. To prevent sand from adhering to the buckets they are attached to the chain with countersunk bolts, and the ends are lapped, thus overcoming the tearing of the sand bodies at the ends as they are discharged from the buckets. For operating the machine only three levers are required, one for clamping the flask, another for rolling over the mold, and a third controls the lowerring of the flask and the draw of the pattern. The levers are located on one side of the machine, obviating the necessity of the operator changing his position while making a mold. The pattern is either vibrated by air or is rapped by hand. The driving mechanism has been placed at the floor level, whereas formerly it was at the top of the machine. The machine is belt driven and is provided

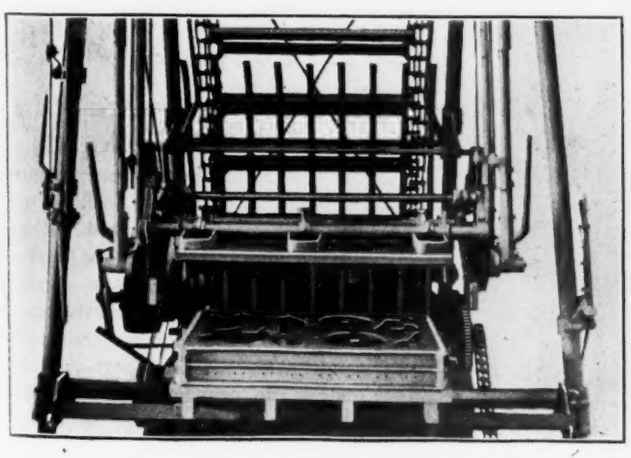


FIG. 5—PATTERN DRAWN.

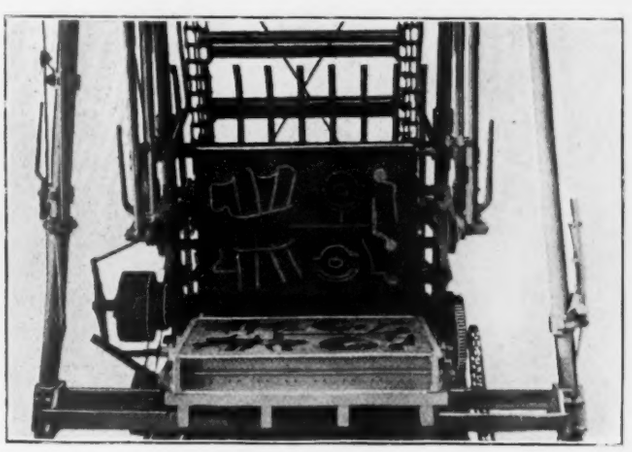


FIG. 6—PATTERN PLATE ROLLED BACK

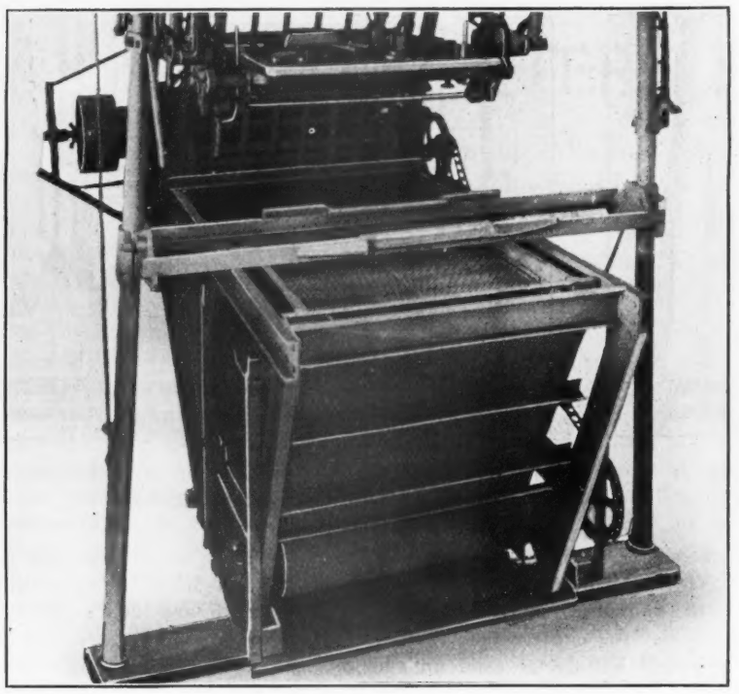


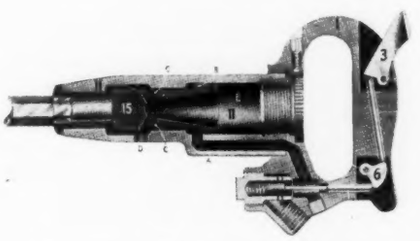
FIG. 7—SAND HOPPER AND RIDDLE

with a friction clutch. The height of the machine above the floor level has been reduced from 17 feet 6 inches to 14 feet, and the depth of the hopper has been decreased from 7 feet 6 inches to 5 feet 6 inches.

When operating the machine the pattern board is placed on the cradle and is clamped automatically by two clamps on either side. The pattern board centers itself as all pinholes are uniform. The flask is then placed on the pattern board and the mold is rammed. The strike-off is next lowered in position as shown in Fig. 1, and the superfluous sand is removed. The bottom board is then placed in position and clamped as shown in Fig. 2. In Fig. 3 the mold is being rolled over and the flask is lowered onto the leveling device shown at A, Fig. 4, which operates automatically. In this illustration the flask is shown just after it has been rolled over and before it was lowered onto the levling device. After the clamps have been released the pattern is drawn by an upward movement of the cradle, which is then moved back and remains in this position until the flask has been removed. A view of the pattern plate partly rolled over is shown in Fig. 6. The cradle is then swung back, the pattern board rolled over, another flask set in place and the operation is repeated.

A front view of the machine showing the sand hopper, cast iron riddle and flask leveling device is shown in Fig. 7, and a side view showing the cradle is illustrated in Fig. 8.

To eliminate the expense of mounting patterns in jobbing foundries, the flask and pattern board can be placed on a car operating on a track, which extends underneath the machine to a point where the cradle rests while the sand is being rammed. While the mold is being rammed on the car the cradle is swung back. The patterns are held in place by hand until sufficient sand has been dropped into the flask to hold them firmly in position, and the ramming operation is then completed. After the bottom board has been clamped, the mold is rolled over and the parting is made by hand. The car containing the drag mold is then again conveyed to the machine, the cope is rammed and the patterns are drawn by hand.



PITTSBURG PNEUMATIC CHIPPING HAMMER

The gravity machine, as well as the other lines of foundry equipment, including the Parks' portable jarring and squeezing molding machine, flask bar and flask, leveling devices, and a full line of snap flasks, formerly made by the Mitchell-Parks Mfg. Co., St. Louis, are now manufactured and sold exclusively by the A. Buch's Sons Co., Elizabethtown, Pa.

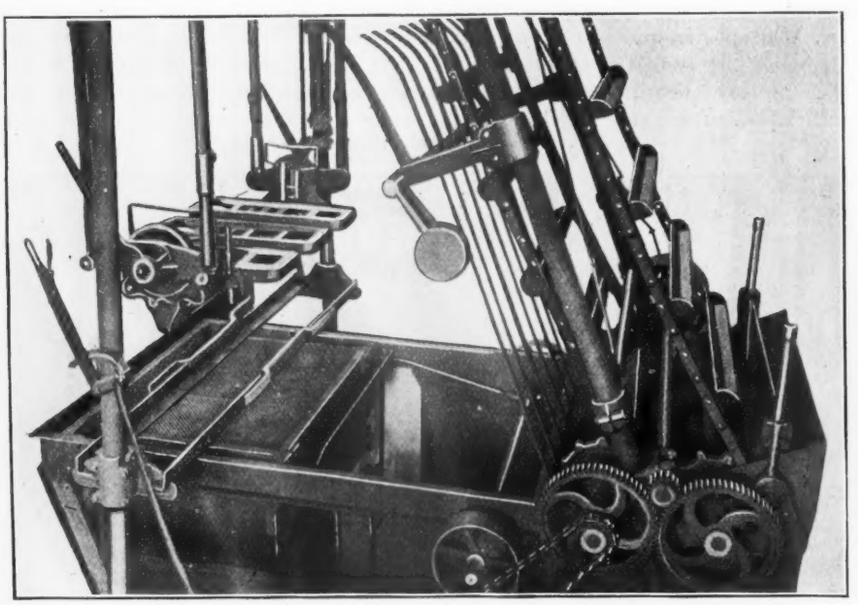


FIG. 8—SIDE VIEW OF GRAVITY MOLDING MACHINE SHOWING CRADLE

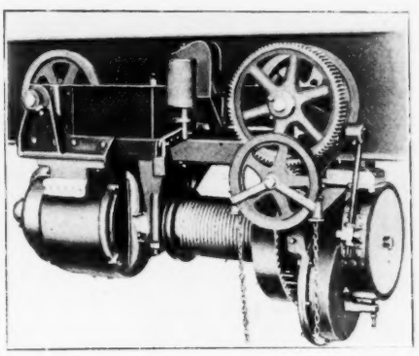
PITTSBURG PNEUMATIC CHIPPING HAMMER.

A pneumatic chipping hammer adapted for chipping castings, plates, calking and flue beading, is shown herewith. Compressed air entering through the port A maintains a constant pressure against shoulder B on the piston and forces it back until the ports C come into communication with the feed port A. Air then enters the cylinder E through the hollow portion of the piston, and acting against the full area of the piston overcomes the constant pressure on the

small shoulder B and drives the piston forward to strike its blow. The piston port C coming into communication with the exhaust chamber D in the cylinder, permits the pressure back of the piston to escape, when the constant pressure on the piston shoulder again moves the piston back as previously stated. Blows are thus repeated in rapid succession. Vibration is reduced to the minimum by the air cushion formed by the pressure admitted through the hollow portion of the piston against which it is returned. These hammers are made in six sizes weighing from 4½ to 10 pounds, with strokes ranging from ½ to 4 inches. These hammers are made by the Pittsburg Pneumatic Co., Canton, O., who also make a full line of pneumatic drills, hand, yoke, stationary and pedestal riveters.

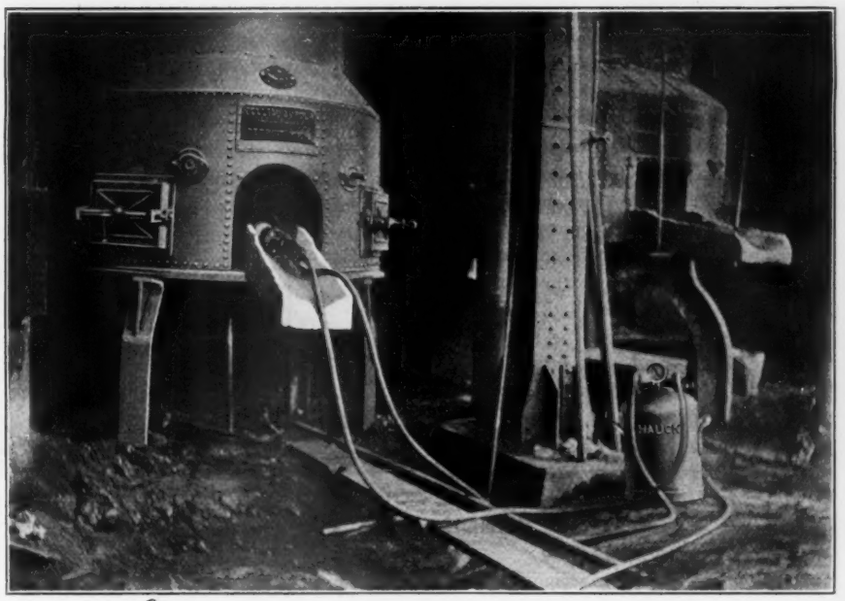
A NEW ELECTRIC HOIST.

A line of small electric hoists for traveling on the lower flange of I-beams or on monorails has been designed and placed on the market by Alfred Box & Co., crane builders,



ELECTRIC HOIST

Philadelphia. The accompanying illustrations shows one of these hoists, which is particularly well adapted for use in foundries, machine shops and other industrial plants where space limitations are such as to render the installation of traveling cranes impossible. This hoist is designed to provide a thoroughly durable device at a minimum cost; it ranges in capacity from two to ten tons, it will travel either on a straight or curved track, and the travel can be performed either by hand or power. The entire frame is of steel, with a large wheel base and all working parts enclosed. The gears are all of the spur and internal type and are cut from solid steel blanks at the Box works. The hoisting drum is grooved to take the full run of the wire hoisting cable, so that there cannot be any overlapping of the rope, which is one of the common sources of wear. A limit switch is provided to prevent the overwinding of the hoisting drum, and an electric brake, operated by a solenoid magnet, and a safety brake of the friction disc type are in place to prevent the running down or racing of the load, a point of importance often overlooked. The small headroom required is evident from the illustration, which is of a two-motor hoist with a capacity of 7½ tons.



HAUCK BURNER LIGHTING A CUPOLA

LIGHTING CUPOLAS WITH AN OIL BURNER.

The accompanying illustration makes clear the manner in which the Hauck Mfg. Co., 140 Cedar street, New York city, adapts its portable oil burner to the lighting of cupolas. This is a rather recent innovation with the Hauck burner, but the arrangement has found favor in a number of large foundries and is being employed with very satisfactory results. No heats have been lost. Weather conditions do not have to be considered, as the burner creates an artificial draft, and no smoke results. The operation of lighting the cupola is shortened in this manner, a good heat is secured without delay, and a hot and clean iron is provided for pouring. The convenience of the system is a noteworthy feature, particularly in view of the annoyance incidental to the use of wood and its steadily advancing price.

THE CURTIS OPEN HOPPER SAND BLAST.

An open hopper sand blast machine designed for cleaning brass, aluminum, iron and steel castings made by the Curtis & Co. Mfg. Co., St. Louis, is shown herewith. The hopper is an open galvanized steel box supported on four angle iron legs. The sand is shoveled onto a screen on top of the hopper and after being riddled, falls on an internal plate and through a series of narrow slots where dust is removed by an air jet, and then falls into the sand tank. The sand is drawn through the opening in the bottom of the tank into the hose by the suction created by the compressed air in the sand blast nozzle. To the nozzle are connected the hose carrying the sand and another hose through which the compressed air is transmitted. Not until the sand reaches the nozzle

CURTIS OPEN HOPPER SAND BLAST

does it come in contact with the compressed air, thus obviating all possibility of the sand becoming moist in the tank. If the nozzle or sand hose becomes clogged, the air can be forced back through the hose by placing the opening of the nozzle against the floor, and any obstruction will be blown out in this way. The machine can be operated at either a high or low pressure and can, therefore, be connected to the compressor equipment alreay installed. The air valve imparts either a high or low velocity to the sand, and the machine can be adapted for cleaning brass and aluminum or iron and steel as desired. The machine is portable and can be used for work in any part of the foundry.

STRIPPING PLATE FOR BENCH WORK.

The application of the stripping plate principle to light bench work without the use of a molding machine, is the subject of a patent recently granted Ezra Estep, Sandwich, Ill. It can be used to advantage for molding small pinions, sprockets, single flange straight-face pulleys, as well as similar work that is difficult to draw with an ordinary pattern plate, as well as for patterns that will not draw freely if gated.

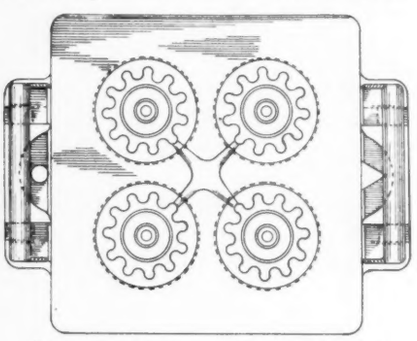


FIG. 1—STRIPPING PLATE DEVICE

A sectional view of a mold with a stripping plate underneath a pattern plate, which contains both cope and drag patterns, is shown in Fig. 3. The stripping plate is illustrated in Fig. 1. Handles are provided for lifting the pattern and stripping plate, as well as for separating the two. Each of these handles is pivoted to the stripping plate and is provided with a cam shoulder for bearing against the face of the pattern plate to separate the two plates when the handle is swung to the position shown in Fig. 1. The upward movement of these handles raises the pattern plate and draws the pattern from the drag half of the mold through the stripping plate. When operating this device, the cope and drag flasks are assembled the cope and drag flasks are assembled with the pattern and stripping plates between them. The drag is rammed, the mold rolled over, and the cope half is rammed drawn from the drag through the stripping plate by raising the handles on either end. Flanges on the latter corresponding to the end flanges of the pattern plate have openings to receive the dowel pins of the flasks. These plates can be used on light flasks or ordinary snap flasks, and are especially adapted for malleable iron work.

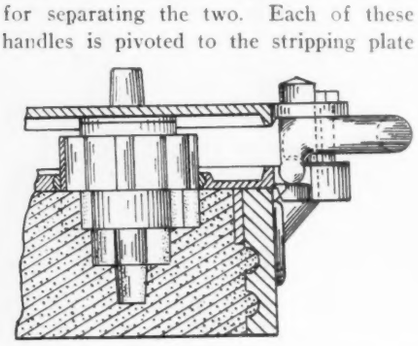


FIG. 2—SECTIONAL VIEW OF STRIPPING PLATE DEVICE AND MOLD SHOWING HANDLE

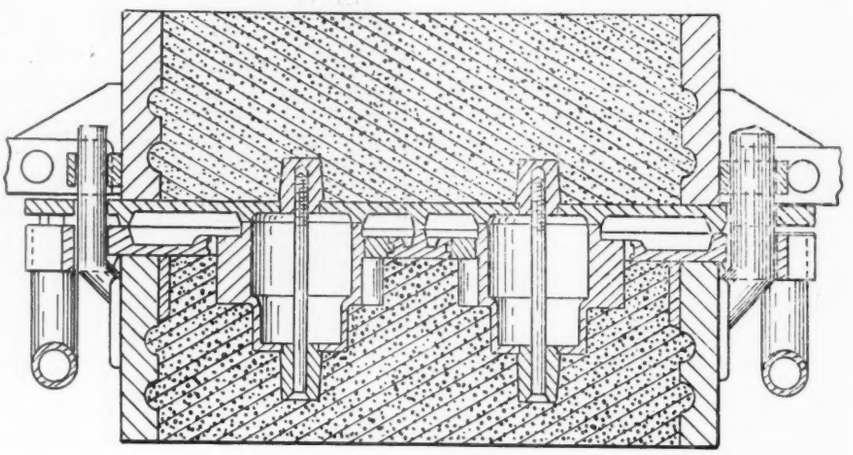
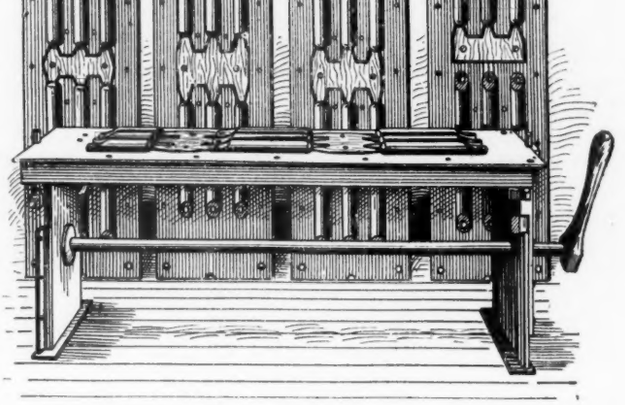


FIG. 3—SECTIONAL VIEW OF MOLD SHOWING STRIPPING PLATE INTERPOSED BETWEEN COPE AND DRAG

A SASH WEIGHT MOLDING MACHINE.

The Advance Radiator Co., Syracuse, Ind., is offering to the foundry trade the molding machine shown in the accompanying illustration, which is designed especially for molding sash weights. The patterns are attached to steel match plates as shown, six or nine to the plate, according to size, and the plate is bolted to the frame of the machine. The molds are rammed by hand and the patterns are drawn by raising the flask from the machine. This is accomplished by pins at either end which are raised and lowered by a lever. In ordinary practice two machines are used, one for making the copes and the other for the drags. The joints of the flasks should be planed so that they will fit accurately on the pattern plates, and if this precaution is observed and the pins properly located, fins and shifts can be entirely obviated. It is claimed that two men operating two machines can produce 13,000 pounds of sash weights per day. Patterns for sash weights of any size, as well as flasks for this special line of work, will also be furnished by the Advance Radiator Co.



SASH WEIGHT MOLDING MACHINE

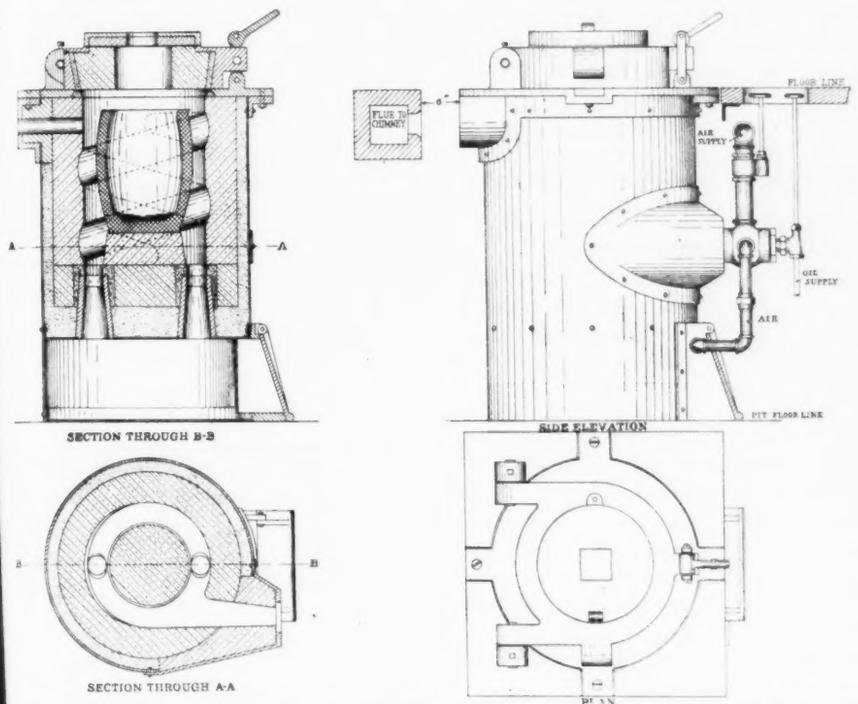
OBITUARY.

Wayne Bougher, 15-year old son of Howard M. Bougher, president of the J. W. Paxson Co., Philadelphia, died of scarlet fever, Feb. 4, at the Mercersburg Military Academy, Mercersburg, Pa.

GYRATING FLAME CRUCIBLE FURNACE.

A side elevation, sectional and plan views of the Kroeschell-Schwartz gyrating flame crucible furnace for melting iron and the softer metals, are shown in the accompanying illustrations. This furnace was originally described in the August, 1908, issue of THE FOUNDRY, but since that date a number of improvements have been made. This furnace is the invention of E. H. Schwartz, and is designed for the use of gas or oil as fuel. The flames are tangentially directed into the furnace causing the same to gyrate around the crucible, thus preventing the cutting action of the flame when directed against the pot. When the burning gases have reached the top of the furnace practically all of the products of combustion have been consumed, and as a result there is practically no oxidation in the top of the crucible.

There are two openings in the bottom of the furnace through which all slag or spilled metal is discharged directly in the pit. These openings also act as tuyeres through which additional air for the combustion of the gases is obtained. The highest temperature is attained near the bottom of the furnace, and as a result the metal in the bottom and sides of the crucible is melted first. A hinged door is attached to the side of the furnace near the floor level, and when this is open the flames are directed downward through the openings in the bottom, freeing the same from any accumulations of slag. Gray iron, steel, semi-steel, as well as the non-ferrous metals can be melted with equal facility. Steel boiler plate punchings have been melted with a fuel consumption of only 10 gallons of oil per 100 pounds of metal. The operation of the furnace is practically noiseless and it is so constructed that the products of combustion pass indirectly into the flue and no fumes or gases are discharged into the melting department. The furnace is built by the Kroeschell Bros. Co., 55 Erie street, Chicago.



SIDE ELEVATION AND PLAN AND SECTIONAL VIEWS OF GYRATING FLAME FURNACE

ROLLED STEEL FLASK.

The Sterling Wheelbarrow Co., Milwaukee, is offering to the foundry trade a steel flask made of a rolled bar of special section, as shown in Figs. 1, 2 and 3. The bar is bent into shape and riveted at one end, the pin holder forming the connecting link. This type of construction makes the flask practically indestructible and it is lighter than cast iron. The sides are of sufficient strength to resist molding machine pressures and it can be sold to the trade at a moderate price. For holding the sand, the sections are flanged on the inside while a strengthening rib is rolled on the outside of the bar. The pin holders shown in the end view, Fig. 2, are made of malleable iron and are so designed that the flasks can be stacked upon

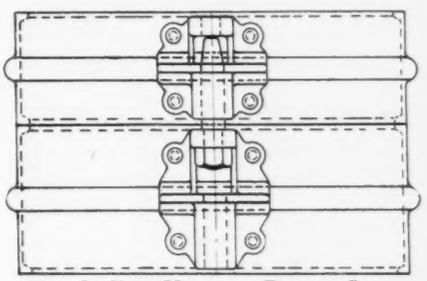


FIG. 2—END VIEW OF ROLLED STEEL FLASK

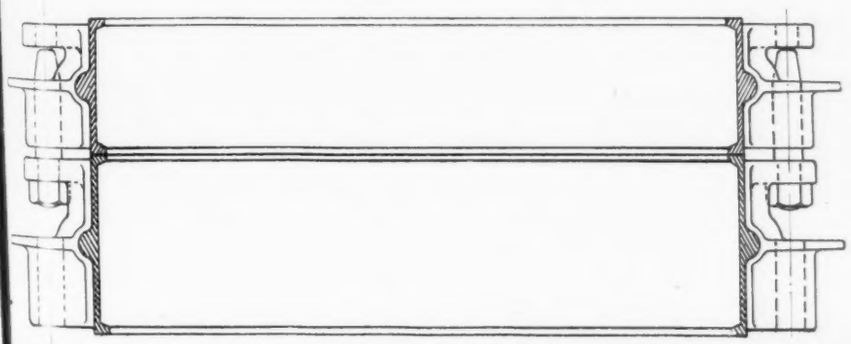


FIG. 1—SECTIONAL VIEW OF ROLLED STEEL FLASK

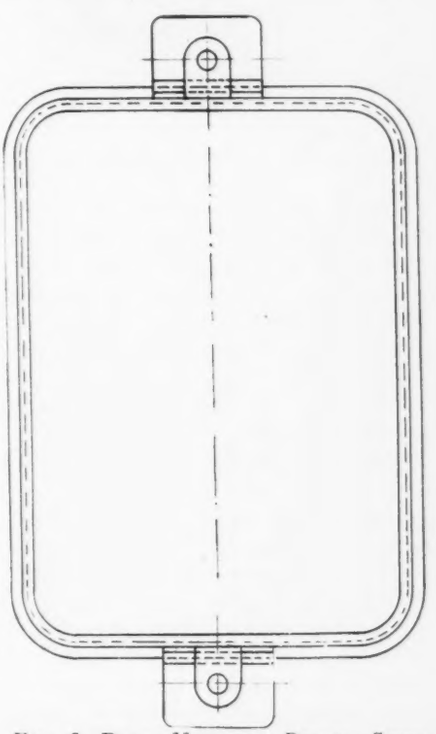
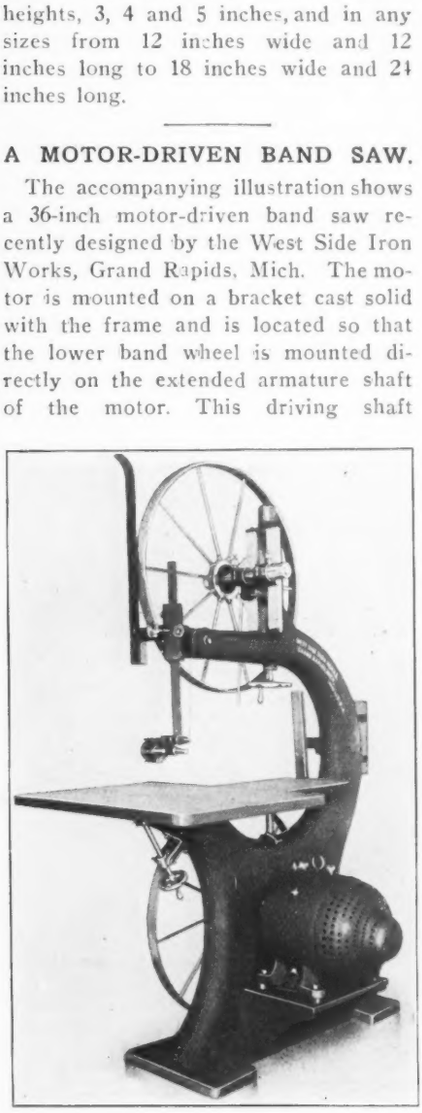


FIG. 3—PLAN VIEW OF ROLLED STEEL FLASK

each other to any desired height. For molding machine work special pin holders are furnished when desired. The flasks are made in three heights, 3, 4 and 5 inches, and in any sizes from 12 inches wide and 12 inches long to 18 inches wide and 24 inches long.

A MOTOR-DRIVEN BAND SAW.

The accompanying illustration shows a 36-inch motor-driven band saw recently designed by the West Side Iron Works, Grand Rapids, Mich. The motor is mounted on a bracket cast solid with the frame and is located so that the lower band wheel is mounted directly on the extended armature shaft of the motor. This driving shaft



36-INCH MOTOR-DRIVEN BAND SAW

passes through the frame, on which it is supported by suitable bearings. The motor is entirely enclosed to exclude dust. The starting box is conveniently located for the operator so that the control of the saw is easy and removed from danger.

The design of the tool itself is simple and substantial. The base is stable and of good proportions. The table is extra heavy and well trussed. It is provided with a screw device by means of which the table may be tilted either way for sawing draft on a pattern or it may be tilted forward for sawing at an angle. No additional locking device is required to hold the table in position. The wheels are 36 inches in diameter, 2 inches across the face with a tire of good quality rubber band, securely cemented on and ground true. The rims and spokes are of steel and the hubs are bell shaped to bring the bearing directly under the strain of the saw. The upper wheel shaft runs in a double yoke box, with 9½-inch bearings and has a tilting device for shifting the saw blade to the desired cutting path. The machine will cut material 16 inches thick and to the center of a 72-inch radius.

The machines can be built either right or left hand, though the former is usually built. They can also be equipped for either direct or alternating current connections.

A LARGE FOLLOW-BOARD.

The follow-board shown in the accompanying illustration is 6 feet 4 inches long, 4 feet 4 inches wide and 1 inch thick. It was made from the "Regular" brand of core oil made by the Holland Linseed Oil Co., Chicago, by E. E. Lindgren, foreman of the foundry of the Standard Architectural Iron Works, Chicago. The oil was mixed with dry saw mill dust, one pound of litharge having been used. After the parting was made the match was permitted to dry about 12 hours and was then ready for use. Owing to its size and weight several rods were fastened in the center of the follow-board.

TRADE NOTES.

The Rockwell Furnace Co., 26 Cortlandt street, New York City, has been awarded the contract for the complete furnace equipment of the new locomotive shops of the Delaware, Lackawanna & Western Railroad, at Scranton, Pa. The contract provides for the installation of 35 furnaces.

The McMullen Machinery Co., Grand Rapids, Mich., has been organized with $15,000 capital and will establish a woodworking machinery depot in that city at 58 South Ionia street. A full line of woodworking machines for every purpose, factory equipment, machine knives and bits, etc., will be carried in stock. The agencies for a number of representative lines have already been secured, although this concern would like to hear from manufacturers of woodworking equipment who would like to introduce their product in western and northern Michigan. G. K. McMullen, president and manager of this concern, was until recently, and for more than 10 years, sales manager of the Fox Machine Co., Grand Rapids, Mich.

The Bigelow Carpet Co., Clinton, Mass., has installed a 20-ton crane in its power station, built by the Northern Engineering Works, Detroit, Mich. The crane has a span of 48 feet and a lift of 31 feet.

Knoppel & Knoppel is the firm name of a new concern organized by J. C. and C. E. Knoppel, Erie, Pa., which will engage in foundry betterment work in an advisory capacity. The scope of the service will include plant arrangement with a view to handling an increased amount of work at the lowest cost. Special attention will be given to melting operations to bring about maximum cupola efficiency, the adaptability of molding machines for various classes of work and industrial transportation facilities. Cost systems will also be devised to meet the particular requirements of the plant for which they are being prepared.

Touche, Niven & Co., 30 Broad street, New York City, public accountants, have established an office in the Trad-

A LARGE COMPOSITION FOLLOW-BOARD

ers Bank Building, Toronto, under the management of Malcolm H. Robinson, a member of the Institute of Chartered Accountants of England and Wales.

The Northern Engineering Works, Detroit, recently shipped a number of traveling cranes to the Black Hills Traction Co., Deadwood, S. D., one three-ton crane to the New Phoenix Foundry & Machine Co., Springfield, Mo., one 15-ton crane to the City of Oswego, Oswego, N. Y., and two 7½-ton cranes to the Western New York Construction Co.

C. W. Leavitt & Co., importers and selling agents of ores, metal and alloys, New York City, announce that after March 20, their offices will be located in the Hudson Terminal building.

The Buckeye Mfg. Co., 2306 to 2312 Eastern avenue, Cincinnati, has been organized by C. J. Goehringer and E. Leisl, and is now engaged in the manufacture of a new parting compound for gray iron and brass foundry use.

It is shipped in 25 and 50-pound boxes and in barrels containing 100 and 300 pounds.

The Metal Mfg. Co., 1826 Land Title building, Philadelphia, recently organized, will engage in the foundry supply business, and will carry a large stock of metals and alloys for prompt shipment at all times. This will include ferro-manganese, metallic manganese, ferro-silicon, manganese copper, ferro-vanadium, ferro-chrome, silica-spiegel, spiegeleisen and manganese oxide. A full line of foundry supplies will also be carried in stock. B. O. Smoot, who has had a wide experience in the foundry supply trade, is general manager.

C. W. Leavitt & Co., 220 Broadway, New York City, are offering to the foundry trade a silicon-calcium-aluminum alloy which is intended for use as a deoxidizing and desulphurizing agent. An approximate analysis follows: Silicon, 47 to 57 per cent; calcium, 15 to 25 per cent; aluminum, 2½ to 6½ per cent. It is claimed that when added in the ladle it calms the steel and insures the production of sound ingots. The alloy can be introduced in the furnace a short time before tapping, or in the tap hole while the metal is being run into the ladle, and it can also be added in the ingot molds.

The Connersville Blower Co., Connersville, Ind., manufacturer of pressure blowers, has increased its capital stock from $200,000 to $400 000.

The Carborundum Co., Niagara Falls, N. Y., will erect an addition to its plant, 60 x 225 feet, six stories high, for the manufacture of garnet and emery paper and cloth.

The Debevoise-Anderson Co., 95 Liberty St., New York, has been appointed sales agent for the Semet-Solvey coke ovens at Chester, Pa. About 40 ovens are operated at this place, catering entirely to the Eastern foundry trade with a product similar to that manufactured in western and northern New York.

GRAPHITE FOR CRUCIBLE MAKING.

Some interesting information in regard to the use of Ceylon graphite for the manufacture of crucibles has come out in connection with a rather spirited controversy carried on recently in *The Manufacturer's Record* over the utilization of the graphite mined in the southern states. George E. Long, treasurer of the Joseph Dixon Crucible Co., Jersey City, N. J., has written two letters on this subject, and from these the following excerpts are taken:

"The importation of Ceylon graphite has averaged for the past 10 or 11 years about 14,000 to 15,000 tons, and of this amount about 70 per cent is used in the manufacture of crucibles. We have found it inadvisable to use the flake graphite in the manufacture of crucibles; the results of our experiments have satisfied us that this form of graphite is not nearly as suitable as the more granular and massive form of crystalline graphite which comes from Ceylon.

"As to the relative amount of American graphite used in crucibles compared with the amount of Ceylon graphite used for this purpose, we would say not more than 200 tons of American graphite could have been used in the manufacture of crucibles in the year 1907, as compared with 12,000 tons of Ceylon graphite; in other words, less than two per cent, and it is quite probable that much less than this was actually used.

"It is not because the graphite produced in the United States is less pure than that produced in Ceylon; it is simply a question of physical structure."

TRADE PUBLICATIONS.

PUMPS.—Catalog No. 74, issued by the Dean Bros. Steam Pump Works, Indianapolis, contains 56 pages and contains descriptions of independent air pumps, jet and surface condensers, vacuum pumps, combined air and circulating pumps for stationary and marine engines, vacuum pans, distillery cookers, etc. The work is well illustrated and contains much valuable information for the power plant engineer.

COMPRESSORS.—The Ingersoll-Rand Co., New York, is sending to the trade considerable literature describing its complete line of air compressors, air receivers, pressure tanks, moisture traps, duplex steam driven compressors, electric-air rock drills and channelers, as well as the Sargeant rock drills.

CRUCIBLES.—The Waterbury Crucible Co., Waterbury, Ct., is sending to the trade a handsomely illustrated catalog which contains numerous halftone illustrations of the various departments of its plant, and sectional views of crucibles are also shown. Considerable valuable information is also given regarding the use and abuse of crucibles, which should prove of value.

GENERAL INDUSTRIAL NOTES

The Onward Brass Co., Kalamazoo, Mich., has placed its new foundry in operation. R. Housam is manager. The equipment was furnished by the Detroit Foundry Supply Co.

Wm. Allen and J. Johnston, Seattle, Wash., have incorporated the Western Malleable Iron Co., with a capital of $100,000.

The Andrews-Stevenson Co., formerly the Vulcan Foundry Co., Hamilton, O., has again changed its name to the Miami Foundry Co. The capital stock of this concern has recently been increased. James K. and William B. Cullen having purchased a large interest Wm. B. Cullen, who for some time was connected with the foundry department of the Niles Boiler Works Co., Hamilton, has been placed in charge of the Miami foundry.

The Quinn Wire & Iron Works, formerly located at Jefferson, Iowa, has completed the erection of a foundry at Boone, Iowa. This concern will be incorporated with a capital of $50,000.

John Westover, Lincoln, Neb., contractor in bridge and structural steel work, is organizing a company which contemplates the erection of a foundry of considerable capacity. The building will be about 100 feet square.

The Turner & Seymour Mfg. Co., Torrington, Conn. will erect a new foundry, 50 x 100 feet.

The Bettendorf Axle Co., Davenport, Iowa, will immediately proceed with the erection of a new steel foundry. This addition was projected last year but was deferred on account of trade conditions. The open-hearth furnaces will be installed by Carr & Spear, metallurgical engineers, 120 Liberty street, New York.

The new foundry of the United Cigarette Machine Co., Ltd., Durmid, Va., has been placed in operation. It is equipped to produce gray iron and brass castings. The foundry was built primarily to make castings for cigarette machines made by this concern, although grate bars will also be produced. The foundry is equipped with a 9-ton Whiting cupola.

The Badger Malleable & Mfg. Co., So. Milwaukee, recently completed a new foundry for the production of malleable iron castings and specialties. The main building which is 444 feet long contains the foundry, annealing room and the shipping department. The molding floor and furnaces occupy a space 260 x 80 feet, the annealing room, 100 x 104 feet, and the shipping department, 90x80 feet. This building is of concrete and brick construction with steel roof trusses. The machine shop is 60x200 feet and of brick and concrete construction, and is provided with cement floors throughout. The pattern storage vault is 20x50 feet, and the office building, 34x36 feet. The sand shed is 24x120 feet and is of reinforced concrete construction, including the roof. The plant is arranged for the economical handling of both raw and finished materials. Coal is dumped directly into bins adjacent to the annealing ovens and furnaces, thus obviating the necessity of handling fuel a second time. The pig iron storage is located between the two main buildings and iron is conveyed into the foundry over an industrial railway system.

The Republic Stove & Mfg. Co., 1802 East 40th street, Cleveland, has built an addition to its plant 60 x 60 feet, two stories high. The office, show and stock rooms have been located in this extension which also provides further shop facilities.

The Powers Foundry Co., Elkton, Md., will add a steel casting department, and has awarded a contract to the J. W. Paxson Co. for the installation of a complete side blow converter plant, the vessel to be of the Paxson-Deemer type.

On Jan. 1, the plant of the Providence Brass Foundry & Machine Co., Providence, R. I., was taken over by the Providence Brass & Aluminum Co. There has been no change in the management, and the change of the firm name was made to avoid possible confusion.

The Germantown Foundry & Machine Co., Germantown, Pa., has just completed its foundry and will make a specialty of light and medium weight soft gray iron castings. The plant is also provided with facilities for general machine work. The officers of the company are as follows: Thomas Why, president; John J. Welsh, vice president; Harry M. Elliott, secretary and treasurer, and Adam Merget, general manager.

The Coatesville Foundry & Machine Co., Coatesville, Pa., has recently completed extensive improvements and the foundry output has been considerably increased. The foundry building is 114 x 210 feet and contains machine shop facilities for finishing castings. The pattern shop is 40 x 60 feet.

The Standard Pattern Works Co., Cleveland, with $10,000 capital, has been organized to take over the business conducted by C. Birnbaum, under the name of the Standard Pattern Works. The officers of the new concern are C. Birnbaum, president and treasurer; D. J. Gutman, vice president and general manager, and W. Birnbaum, secretary. Considerable pattern shop machinery has been purchased.

The plant of the Fulton Foundry & Machine Co., located at Kirkwood, Ga., a few miles east of Atlanta, has been purchased by Geo. Hurt, who will operate the same under the name of the Pratt Engineering & Machine Co.

The plant of the Tumney Copper & Bronze Co., East 67th street, Cleveland, O., has been purchased by M. J. Hancox, of the Standard Pattern Works, of that city. A new concern called the Industrial Pattern & Bronze Co. has been organized to operate the plant.

The Paxton Foundry & Machine Co., Paxton, Ill., has added a foundry to its plant which is equipped for the manufacture of iron, brass and aluminum castings.

The Pennsylvania Foundry Co., Johnstown, Pa., has been incorporated by George W. Thomas, William B. Rodger and Joseph G. Thomas.

The Empire Car Wheel Co., Buffalo, has been organized to engage in the manufacture of car wheels and gray iron castings. The incorporators are Seward H. Miliner, Wm. J. Donovan and Edward H. Murphy, of Buffalo.

A controlling interest in the Glamorgan Pipe & Foundry Co., Lynchburg, Va., has been purchased by leading business men of that place. During the past six years the plant has been greatly extended and the capacity practically doubled. The new management does not contemplate extensive improvements in the near future.

The Star Foundry Co., Seattle, Wash., has been incorporated with $6,000 capital by Clarence H. Reed, Clyde R. Dodds and Doris R. Dodds.

The Empire Foundry Co., Syracuse, N. Y., has been incorporated with $40,000 capital by Grant D. Green, Thomas Van Ornam and George D. Chapman.

John Markley and associates of Chicago, owners of the Armor Steel & Foundry Co., Mathews, Ind., have purchased from the receiver, the plant of the Steel Foundry Co., Cincinnati, for $60,000. The plant was appraised at $229,240.36, and the total liabilities were $299,356.30. The book accounts, which amount to $23,119.84, were not included in the purchase. The plant will be placed in operation at an early date and another open-hearth furnace will be added. The payment of the purchase price is to be secured by the deposit of $250,000 of first mortgage bonds of the Armor Steel & Foundry Co. in escrow with a Cincinnati trust company, and one-half of all sales of the bonds is to be applied as rapidly as such sales are made, to the payment of the obligation until it is met.

W. B. Perry & Son, 29 Liberty street, Utica, N. Y., have purchased a foundry at 314 Catherine street. This plant has been idle for some time and improvements are being made preparatory to early resumption.

The Superior Bronze Co., Wilmington, Del., has been incorporated with $10,000 capital by Geo. Turner, Marshall A. Roddy and Geo. W. Dorsey Jr., all of Wilmington.

The Herron Pump & Foundry Co., Chattanooga, Tenn., has been reorganized by the election of J. W. Conway as president; Geo. M. Guild, vice president; H. M. Lofton, general manager, and C. D. Richmond, secretary and treasurer. The reorganized company has a working capital of $125,000.

The Adrian Steel Casting Co., Adrian, Mich., manufacturer of crucible steel castings, has purchased the iron foundry business of the Kells Foundry & Machine Co., at Adrian, and will engage in the manufacture of gray iron as well as crucible steel castings.

The Blume Mfg. Co., Passaic, N. J., manufacturer of art metal ware, will remove its plant to 397 Broad street, Newark, N. JJ.

The Cincinnati Steel Foundry Co., Cincinnati, recently incorporated with $50,000 capital, will occupy the plant formerly operated under the firm name of the L. Jones & Sons Foundry. John L. Hopper, formerly connected with a steel foundry in Minneapolis, will have charge of the affairs of this concern.

The Star Foundry Co., Inc., Seattle, Wash., is the firm name of the new concern that succeeds Reed Bros. & Dodds.

The Milwaukee Pattern & Mfg. Co., Milwaukee, has been incorporated with $20,000 capital by Emil Seidel, F. A. Drolshagen and Daniel W. Hoan.

The Atlas Foundry Co., Marion, Ind., has commenced operations in the building formerly occupied by the Ward Fence Co.

New Construction.

The Hart-Parr Co., Charles City, Iowa, will erect a steel foundry 120 x 200 feet for the production of steel castings. One furnace with an output of eight tons per heat or about 25 tons per day will be installed, and this concern is now in the market for a complete line of steel foundry equipment, including pneumatic chippers and rammers, cold saws and shapers, traveling cranes, sand mills, molding machines, etc.

The F. W. Wyatt Mfg. Co., Salina, Kans., contemplates the erection of a foundry 50 x 200 feet.

The Tallman Brass & Metal Co., Hamilton, Ont., contemplates the erection of a new foundry within the next few months which will more than double its present capacity. This concern manufactures brass castings, babbitt metal and solder.

The Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., is increasing its annealing department by an extension, 60 x 80 feet, and is adding several ovens to increase the annealing capacity to about 15 tons daily.

The Holm's Mfg. Co., Sparta, Mich., recently incorporated with a capital of $100,000, will erect a plant for the manufacture of gasoline engines, concrete machinery, etc. The plant will include a pattern shop, foundry and machine shop. The foundry will be 100 x 202 feet and the pattern shop 50 x 50 feet. A ten-ton cupola will be purchased, as well as molding machine, ladles, etc. Peter J. Holm is president and J. E. Reployle secretary and treasurer. The equipment will be purchased by Dr. J. H. Holm, 1861 Gladys Ave., Chicago.

The Syracuse Die Molded Casting Co., Syracuse, N. Y., has been incorporated with $100,000 capital to engage in the manufacture of finished castings from alloys about equal in strength to ordinary brass castings. All of the castings will be made in dies, which will prevent any variation in size and will, to a large extent, eliminate subsequent machining. This method of producing castings is adapted to a large variety of work, including small gears, numbering machine parts, telegraph and telephone instruments, electrical apparatus, etc. A portion of a factory building at 303 Wallace street has been leased. The officers of the copmany are: O. M. Gale, president and treasurer; O. E. Stowell, vice president, and L. H. Johnston, secretary.

The Sivyer Steel Co., Milwaukee, has been incorporated with $25,000 capital to engage in the manufacture of crucible steel castings. The furnaces will be immediately installed in one of the foundry buildings rented from the Northwestern Malleable Iron Co., which is 200 x 70 feet. The incorporators are: Fred L. Sivyer, vice president of the Northwestern Malleable Iron Co., William C. Frye and Donald Fraser.

The Weatherly Foundry & Machine Co., Weatherly, Pa., has decided to erect a steel foundry in addition to its present gray iron plant. The new building will be 70 x 140 feet, of steel and concrete construction. This concern is now in the market for the following equipment: Two 2-ton converters, blowers, motors, etc.; one 15-ton, 50-foot span electric traveling crane, sand grinder, oil tank, oil burners, ladle heating and annealing furnaces, etc.

The Oklahoma Stove & Structural Iron Co., Oklahoma City, Okla., is having plans prepared for a foundry, 70x200 feet, mounting shop and warehouse, 60x100 feet, and power plant, 30x40 feet. This concern was recently organized with $75,000 capital. The officers are as follows: Wm. H. Mathias, president; Wm. F. Bush, vice president; David L. Meyers, treasurer, and John H. Meyers, secretary.

The Chester Gray Iron Foundry Co., Chester, Pa., recently organized, will shortly begin the erection of a foundry, 40x60 feet, with a wing extension, 54x60 feet.

The Gerlinger Steel Castings Co., West Allis, Wis., has purchased additional property adjoining its plant for the erection of an addition to its foundry, 40x30 feet.

The remodeling of the Triton Mills, New Castle, Del., by the Deemer Steel Casting Co., which will convert this plant into a steel foundry, is now in progress. The main foundry building will be 300 feet long and will have an average width of about 73 feet. A wing parallel to the main building, 45x130 feet, will be devoted to bench molding. The pattern shop and storage building will be 39x87 feet and the furnace department in which the cupolas and converters will be erected, will be 50x60 feet. S. S. Deemer is president and general manager, and including Mr. Deemer the board of directors comprises Edward T. Price, Wilmington, Del.; A. P. Witteman, W. G. Parsons and T. E. Austin of Philadelphia, and J. V. R. Hunter of Reading, Pa.